PRESCOTT, S.C.

EXAMINATION OF TROPICAL SOILS

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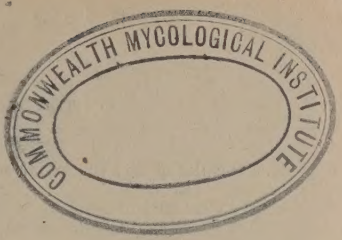

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JULY 1, 1918.

A. W. PRESTON, Esq., President,
United Fruit Company,
Boston, Mass.

Dear Sir: I submit herewith a Report of the Examination of Tropical Soils, together with letter of transmittal of Professor Samuel C. Prescott to me. This work has been undertaken the past two years by Professor Prescott and his assistants under the direction of this office.

While this report does not throw a great deal of light on the problem of overcoming banana disease, I consider the general information as to soils of great value to this Company.

I am having this report distributed by the Tropical Division Managers among their subordinates in the Agricultural Department. It will be the policy of the Company to require these men to study carefully this report with a view to increasing their efficiency in the agricultural operations of the Company.

Respectfully,

VICTOR M. CUTTER,

Vice-President.

pointing out the inadequacy of chemical examination by itself as a means of judging the character of soils. Bacteriological examination is now regarded as of equal importance with the chemical since we are beginning to discover the ways in which interaction between bacteria, organic matter and mineral matter in the soil takes place. Soil bacteriology, however, has not previously been so thoroughly organized as to lead to clear-cut conclusions and it is still in a developmental state. I believe, however, that it would be of great advantage, as supplementary to this work, to select a small number of representative areas in each division and subject them to a general microbiological examination as well as to the chemical, physical and mechanical analyses. Should the conditions for resuming the investigation work again become favorable, I believe some work of this character would be distinctly worth while.

It is an unfortunate fact that the investigation has thrown little light on the question of disease. In a broad way it is perhaps somewhat evident that in those soils which are most heavily impregnated with food materials and where the banana has reached the highest vigor, the infections of the fungus of disease and its disastrous results have been less marked. This is a result which is in harmony with other results we have already obtained, and of which we have innumerable striking parallels in the animal kingdom. There seem, however, to be no strikingly marked correlations between the chemical character of the soil and the spread of the disease except in a few instances, although possibly further scrutiny and close study of our results may reveal some correlations which do not appear on the surface.

Judging by the usual methods of evaluating soils by erecting standards of analysis we are

brought to the conclusion that only a small percentage of the soils which we have examined could be classed as really poor, and the great majority of them would be rated as above normal or rich in fertility and food value for plants. In this connection it may be pointed out that tropical soils have been found by all observers to fall in a different category from the soils of the temperate zone where most of the analytical work has been done.

Before giving the actual figures of the analyses I have written somewhat fully the most important facts relative to soil formation and the requirements of plants, believing that the figures become more intelligible when the fundamental facts or principles are set forth. This, I hope, will prove of interest and use to the officers of the Company in their perusal of these results, and perhaps in future investigations, if such are undertaken.

In conclusion, I wish to express most emphatically my great indebtedness to the Managers and Superintendents of the different Divisions who have done everything possible to facilitate the work of collecting the samples, and who have prepared the statements of the agricultural history of each of the localities where samples were taken.

Very truly yours,

SAMUEL C. PRESCOTT.

culture, is less firmly established on a solid basis of fact than is any other of the productive arts. That this is due in reality to the complexity of the questions involved is probable, for the study of soils actually involves the application of chemistry, physics, geology, botany, microbiology and climatology. A survey of the recent works on soils has left the writer with the one predominant impression that here is a great field of study in which only the most obvious facts have been learned, although agriculture is one of the oldest pursuits of man.

II. Object of the Investigation

The objects of this investigation are fourfold.

First, to obtain and correlate data bearing on the composition of soils and to secure as much accurate knowledge as possible of what may be regarded as typical banana soils.

Second, to determine by a study of the chemical results, as compared with the mineral requirements of the banana plant, if exhaustion of soil is taking place in the older farms, leading to lowered resistance and weakened productivity of the plant.

Third, to be able to make direct comparisons of the soils of different divisions.

Fourth, to determine if possible any relation between the soil conditions and the occurrence of fungi or other micro-organisms which might react harmfully upon the crop.

These may be somewhat further explained.

1. The investigations, the results of which are here reported, were undertaken in the hope that some data could be collected and correlated which would be of value in establishing a more intimate and accurate knowledge of the soil conditions essen-

tial in the production of an important food crop—the banana. At the outset it was thought that possibly major differences found in chemical or mechanical composition, in physical qualities or in microbic contents might, when taken in connection with the agricultural histories, explain why one soil is of exceptional quality while another near by is mediocre or poor; why on one farm the crop has maintained a high level of productivity and freedom from insect or fungus pests, while in another location with seemingly as favorable conditions the productivity has not been maintained and the plants have been subject to attack from enemies.

2. A consideration of the food requirements of the plant suggests that after several years of cropping with no rotation there might be an exhaustion of the needed food materials, either organic or inorganic. It is known from the analysis of the ash of plants that certain mineral salts are required for their best development, and that lack of any of these compounds may lead to low productiveness, weakened and stunted plants, greater susceptibility to diseases, and generally poor crop conditions. Do such conditions arise in the tropics as a result of intensive cultivation and are they discernible by chemical examination of soils? On this question we have tried to obtain information since it fundamentally affects agricultural operations and, furthermore, opens up the whole question of fertilizers and their function.

3. This investigation has been planned and carried out with the purpose of comparing directly the conditions in the six divisions of the United Fruit Company engaged at the time in the production of bananas. These divisions differ somewhat in their geologic history and their climatic conditions, but on the whole are fairly comparable since all lie within the tropical belt and, with the exception of Jamaica,

have had agricultural histories fairly similar in character, although of varied duration.

4. Finally, the investigation has sought to throw some light on the occurrence and spread of the special type of fungus infection known as the Panama Disease, by studying the character of the soils where this infection has been found and comparing directly with other locations where its ravages are not known or are less severe.

III. Scope of the Investigation

This work was begun in the latter part of 1916. The general plan involved a soil survey of the banana-producing areas owned or controlled by the Company in Guatemala, Honduras, Costa Rica, Panama, Colombia and Jamaica. In each of these divisions a sufficiently large number of samples was collected to give an unbiased idea of the actual soil conditions prevailing, and a comparison of areas known to be of high productivity with other areas of less favorable history. Whenever possible, the agricultural history of the area selected for examination has been secured, as this offers another means of comparison and a possible factor for correlation. In general, more than thirty areas have been taken in each division. These include what may be called old farms, that is, those which have been under cultivation for ten to twenty years; new farms, or those in production but few years; abandoned areas and virgin forest or bush land. The majority of the samples, however, have been taken in the producing farms. Since the divisions differ considerably in the length of time they have been under cultivation, the results are not always directly comparable from the point of view of age, but do offer interesting grounds for general comparison of chemical and other data.

Another factor of great interest in the study of tropical soils has to do with the effect of flooding. Do those areas which receive periodically the inundations due to excessive rainfall in the mountains behind and above secure thereby through silting a constant renewal of food materials, or is the material so received without food value and of disadvantage? Is this observable in the chemical analysis of such areas as compared with areas never flooded? The scope of the work has been planned to cover this and similar matters.

The scope of the investigation has not been solely chemical, but an attempt has been made to determine so far as possible in connection with the chemical analyses the mechanical character of the soils, their physical qualities, such as appearance and color, and to some extent also the microbiological condition of the soils. While it has been impossible under the conditions to make complete bacteriological examinations or even complete determinations of the fungi occurring in the soil, an attempt has been made to determine whether the particular type of organisms known as Fusarium, which is responsible for the most serious known infection of the banana, is or is not constantly present in the soils where the banana is cultivated. Altogether this chemical, mechanical and biological study of more than two hundred samples of soil probably constitutes the largest soil investigation ever carried out for the purpose of such direct comparisons. Moreover, each sample taken has been divided into three portions, according to the depth, so that for each sample we have an actual study of the top six inches, which represent in a general way the character of the soil which supplies nutriment for the growing crop; a second sample, extending from the six-inch level to eighteen inches, and finally a third portion representing the material

collected from a depth of eighteen to thirty inches, or what may be properly considered as a subsoil. All these samples have been treated in exactly the same way so that in reality there have been examined approximately 642 samples from 214 different areas.

Sampling

For the collection of the samples, a special form of apparatus was devised, consisting of a two-inch wrought-iron pipe with a handle at the upper end. This pipe was perforated with slots to facilitate removal of the sample, and the lower end ground off to an edge in order to cut through the soil more readily. When possible, the section of soil was obtained by gradually pushing or working the sampler into the ground by hand. In general, however, it was found necessary to use a hammer in order to penetrate the soil, and for this purpose a lead hammer was utilized. In collecting the samples the pipe was driven into the ground to a depth of six inches and this sample removed and properly marked. The sampler was then replaced in the same hole and driven to a depth of eighteen inches and the sample again removed from the pipe, and finally the third portion from the depth of eighteen to thirty inches was obtained in the same way. The samples were immediately placed in No. 3 friction-top tin cans, sealed and marked with the serial number and such other distinguishing characteristics as would make their location certain. Two duplicate sets of samples were obtained, one of which was forwarded to the Laboratory in Costa Rica for mycological and mechanical analyses there, the other set being shipped to the Boston Bio-Chemical Laboratory in Boston where mechanical and chemical analyses were carried out.

IV. General Methods of Examination

As previously stated, the samples have been subjected to chemical, physical and mechanical examinations. In addition to this, there has been prepared for each area or section studied, a brief account of the topographical features, drainage and flood conditions, the type of forest growth, and the record of the cultivation history wherever it has been obtainable. This cultivation history aims to give in as concise and as detailed a way as possible, a record of the time when crops were first cultivated on the land, what crops have been grown, the general conditions of productivity and such other data as might seem to be of value or interest in connection with the agricultural history of a farm. Furthermore, wherever any plant diseases have appeared, and particularly the Panama Disease, a record of its first appearance and of its severity has been made.

Physical Examination

Under the general head of physical examination we have noted the color, compactness and friability of the soil and have made a careful laboratory test of its retentive power for water. This expresses in a general way the percentage of water which a soil will hold mechanically, based on the weight of the soil.

Mechanical Examination

It has long been known that the quality of a soil depends to a certain extent upon the coarseness or fineness of the particles. With this in view, there have been worked out numerous schemes for the mechanical separation of soils into the general classes

of gravel, sand, silt and clay. The separation is based on difference in the actual size of the particles, gravel constituting the coarser portion. Obviously the origin of the particles is of importance.

In the British and American methods of analyses there is a slight difference in the size of the particles which would be grouped in any particular class, although in a general way it may be stated that the gravel consists of the coarser material while the clay consists of the very finely divided matter which it is impossible to settle out completely on standing. The coarser portions are easily determined by means of carefully standardized sieves, while the finer material requires a water treatment in which the time required for settling is the determining factor.

Chemical Examination

The elements which are regarded as of importance or essential to the life or healthy condition of plants are as follows: carbon, hydrogen, oxygen, nitrogen, potassium, magnesium, calcium, phosphorus, iron and sulphur. In addition to these a small amount of silica is generally found, although it is not absolutely essential. The carbon, hydrogen and oxygen either with or without the nitrogen may be combined in the form of organic matter. This organic matter is especially of great importance in the soil, since the indefinite compounds known as humus are made up of these compounds. The nitrogen is ordinarily present in the form of organic bodies containing nitrogen, ammonium salts and nitrates, but especially in the last named form. The ammonium salts under the influence of microbic agents are usually quickly transformed to nitrates, and the same is largely true of the organic nitrogen, although it is possible that certain forms of nitrogen may be directly used by the growing plants. In our ex-

aminations, therefore, the chemical determinations which have been made are the organic matter, the total nitrogen, the potash expressed as oxide, phosphoric acid expressed as phosphorous pentoxide, calcium expressed as lime, magnesium expressed as magnesia (oxide), iron expressed as ferric oxide. In some instances the aluminum salts have also been determined.

Mycological Examination

The mycological examination, as previously stated, has been carried out primarily to determine whether the special fusarium causative of the Panama Disease of the banana is present or absent.

All these methods may now be considered in detail.

V. Detailed Account of the Methods Employed

1. *Physical Examination.* No special physical methods of examination have been employed except in the study of the retention of water. The classification as to color, compactness and friability is very simple, and when a large number of samples are compared side by side, as has been the case in this investigation, the gradations in color, solidity and general workability are fairly obvious. For the study of retentive power, however, it is important to have the soil thoroughly dried and finely divided and to carry out the procedures in a careful manner. This is generally done by placing a definite weight of the soil in a suitable form of funnel and carefully adding distilled water so long as the water is held back by the porosity of the soil itself. By measuring the amount of water thus added and comparing with the weight of the soil, a direct reading of the retentive power of the soil is obtained.

2. *Mechanical Examination.* The mechanical analyses in the soils here reported have been done in duplicate, first in the Research Laboratory in Costa Rica soon after the samples were collected and before they had an opportunity to change, and in the second place at the Boston Bio-Chemical Laboratory where all the chemical examinations have been carried out. The samples were treated in a similar manner at both laboratories.

The samples were air-dried, thoroughly mixed, sticks removed, the large lumps broken up and 10 grams of the material taken. If stones were present their size and weight were noted. This sample was run through sieves carefully standardized and rubbed gently with a wooden pestle to break up the small lumps of clay and organic matter, thus reducing all to a particulate form. By the use of a standard series of sieves, the sample was then classified according to the size of the particles, the larger particles varying in diameter from two down to one millimeter. The particles which would not pass the 2-millimeter aperture were called coarse gravel, while those which passed through the 2-millimeter opening but were held back by a 1-millimeter opening were classed as fine gravel. Similarly, those passing a 1-millimeter, but not a .5-millimeter sieve were described as coarse sand, while by fine sand is meant the material which passed the .5-millimeter but were held back by .1-millimeter opening. The portion consisting of particles with a diameter of less than .1-millimeter consisted of silt or clay. The separation of these two fractions was obtained by the water treatment method in which the whole portion passing the 1-millimeter sieve derived from 10 grams of soil is put in a beaker of water, thoroughly stirred, and allowed to settle for a period of thirty minutes. The material settling out at the end of thirty minutes

is classed as silt, while the clay consists of the extremely fine particles which do not settle when treated in the above manner or under a rest period of thirty minutes. Many particles of clay would remain in suspension indefinitely unless some substance such as the silt is added which affects their collodial condition. In all instances the presence of pebbles, large stones or coarse gravel in any samples is noted in the sheets on which the results of all examinations are reported.

3. *Mycological Examination.* All agricultural soils contain enormous numbers of bacteria along with numerous types of molds, higher fungi, protozoa and other microscopic animal forms. Evidence has been gradually accumulating that the character of the soil may be quite as much determined by the bacteriological changes and reactions taking place in it as by its chemical constitution. This fact had not been so firmly established at the inception of this work and therefore it was deemed advisable to restrict the mycological studies to the special examinations of the soil for the group of fungi known as *Fusaria.* This group of organisms is of special importance since it is very widely distributed and contains a large number of types which are pathogenic for many kinds of plants, that is to say, one particular species or type of fusarium seems to be especially active with and harmful to one particular host plant, but to be entirely without action upon other plants. Our studies upon the Panama Disease had established the fact that this particular disease of the banana is due to a special type of fusarium and in the course of our laboratory work in Costa Rica some methods of soil examination for fusarium were developed. The methods at first employed were subsequently greatly improved through the investigations along this line conducted by Messrs. Waters and Funk with the result that

a differentiating medium for the particular fusarium of Panama Disease was discovered. This medium while permitting the abundant development of the special fusarium when present, restrains almost perfectly the bacteria and other forms of fungi except for a few nearly related species. The medium employed is made up of a mixture of 1% sucrose, 1% agar and 2% cornstarch in water. This is sterilized and tubed and when used, one cubic centimeter of a 2% sterilized lactic acid solution is added to the Petri dishes containing the soil to be examined.

The soil to be examined is evenly distributed over the plate, the culture medium above described is then poured on and allowed to cool. In three or four days the colonies of the fusarium causing Panama Disease develop as reddish spots on the plates. The fusarium of the *Martiella* group grows as white colonies, while the *Fusarium discolor* appears yellow. In all examinations it is possible with a known amount of soil and with a known dilution to secure approximately quantitative amounts of the fusaria of the different classes. In general, however, we have been especially interested to determine whether these organisms are or are not present, and not to determine the actual numbers of cells. The cultures obtained by the above method were then examined by inoculating upon steamed rice and then incubating for a few days when the characteristic odor of the fusarium of Panama Disease can be detected if that organism is present. Another qualitative method which has been followed in our investigations is to add some of the soil, or an infusion of it, directly to the rice tubes. If the Panama Disease organism is present, after three or four days a pink growth appears, characterized by a "lilac" odor (or an odor which resembles a mixture of lilac and gasoline) when the cotton plug is removed. So

far as known, the fusarium of Panama Disease is the only fusarium which gives this odor on starch material, and a large number of tests with other fusaria have been made in working out this particular method of examination. In our soil survey the rice test was used with all samples, and the presence of Panama Disease determined by the color and odor. Colorado Disease gives a pink color, sometimes varying toward orange, but no odor. Another fusarium found in soils in Castilla and in a few plants in that district in Santa Marta gives a white color on rice, with no odor. All the soil samples were tested by the above method at the time the sample was taken so that there could be no possibility of the fungus dying out as a result of drying, and care was taken to prevent contamination at the time the culture was made.

4. *Chemical Examination.* The chemical analyses of the soils were made practically as laid down by the Association of Official Agricultural Chemists, which organization has developed methods which may be regarded as standard for various types of analytical procedures bearing on agriculture. Two modifications were introduced, one in the determination of magnesium, in which case the Schmitz method, described by Treadwell and Hall, was used, and the other the estimation of calcium oxide or lime in which the calcium oxalate found was determined by the use of a solution of potassium permanganate. The detailed methods are given below.

Samples of the soil were prepared for analysis by first air drying the large sample, quartering down to about 30 grams and then breaking up this portion in a mortar, taking care not to grind. This sample was then shaken in a sieve containing 1-millimeter circular openings, and such portions as passed the sieve became, after thorough mixing, the prepared samples.

The moisture was determined by drying a 2-gram

sample in a silica dish for five hours at the temperature of boiling water. The dish was then cooled in a desiccator and weighed. It was then returned to the oven for an hour and if the weight was not constant, this was repeated until the proper end weight was obtained.

Organic Matter: The organic matter was obtained by heating this dry soil to full redness and stirring until all the organic matter had become consumed. The dish was then cooled in a desiccator and weighed. The loss of weight was reported as total organic matter, although containing some water of combination and ammonium salts.

For the determination of the ferric and aluminum oxides, magnesium, phosphoric acid, and potash, a hydrochloric acid digestion of the soils was made as detailed below and the resulting solution used. Ten grams of moisture-free soil and 100 cubic centimeters of hydrochloric acid (sp. gr. 1.115) were placed in a 300 cubic centimeter Erlenmeyer flask fitted with a rubber stopper carrying a reflux tube from 20–28 inches long. The flask was then placed on the steam bath and the soil digested for ten hours with frequent shaking. After settling, the solution was decanted into a casserole, the soil washed upon a filter, washed free from chlorides, and the wash water and solution united in the casserole for evaporation. A little nitric acid was added to the solution to oxidize the organic matter as it came to dryness. The residue was then taken up with hot water and a few cubic centimeters of hydrochloric acid added, and the solution again taken down to dryness. The casserole was then cooled, a few drops of strong hydrochloric acid added to moisten the residue, hot water added, and the solution heated in the bath to dissolve all but the silica. The silica was then filtered off and washed free from chlorides. The solution was a

second time taken down to dryness as before and any silica still in solution was thus separated out. The silica-free solution was now made up to 250 cubic centimeters, and became the stock solution used for all subsequent determinations as mentioned.

Iron (Ferric oxide—Fe_2O_3): To 50 cubic centimeters of the stock solution already heated on the water bath, sufficient ammonium hydroxide was added, with stirring, to precipitate all the iron, aluminum and phosphates. As soon as the precipitation was completed the solution was filtered through a quantitative filter and washed several times. The precipitate was then dissolved on the filter into the original beaker by means of a weak solution of hydrochloric acid, and the iron again precipitated and filtered through the original filter. The precipitate was then washed free of chlorides and the wash water added to the first filtrate and reserved for the calcium and magnesium determinations. The iron in the precipitate was determined by dissolving the precipitate in weak hydrochloric acid and titrating with a tenth normal solution of potassium permanganate, after reduction in a Jones reductor.

The calcium was determined in the filtrate from the iron precipitate by precipitation with ammonium oxalate in the boiling solution. After two or three hours on the water bath or one-half hour boiling over the free flame, the calcium oxalate was collected on a quantitative filter and washed free from chlorides—partly by decanting before throwing on the filter. The calcium oxalate was then dissolved in sulphuric acid 1 : 4, and the calcium oxide or lime estimated by titration with a tenth normal permanganate solution.

The magnesium in the filtrate from the calcium precipitate was determined by evaporation of the filtrate and washings to a volume of 100–150 cubic centimeters. To this acid boiling solution sodium

phosphate was added in excess with stirring. Then the beaker was removed from the flame and 10% ammonium hydroxide equal to one-third the total volume added and the solution set aside for three hours. This gave a coarse precipitate which was filtered off, washed with a 2.5% ammonia wash water until free from chlorides and weighed as magnesium pyrophosphate.

The potassium determination was carried out on a separate 100-cubic-centimeter portion of the stock soil solution. The iron, alumina, phosphoric acid, and calcium were first precipitated as just described and the solution evaporated to about 5 cubic centimeters in a platinum dish. One cubic centimeter of a 1 : 1 sulphuric acid was then added and the solution brought down to complete dryness. The ammonium salts were then driven off by heating to a dull redness. The residue was then dissolved in a few cubic centimeters of water and an excess of platinic chloride added. The solution was evaporated to a pasty mass and 80% alcohol added to dissolve out the sodium salts. The precipitate was then thrown on to a tared Gooch filter and washed several times with 80% alcohol, then with several portions of a solution of ammonium chloride (1 : 5) saturated with potassium platinic chloride. This washing was then followed by washing with 80% alcohol and the filter and precipitate dried for thirty minutes at 100° C., cooled in desiccator and weighed. The factor .1938 was used to obtain the weight of potash.

The phosphoric acid was determined in a separate 100-cubic-centimeter portion of the stock solution which was first evaporated down to about 25 cubic centimeters. Ammonium hydroxide was then added to neutralize the acid and about 3 grams of dry ammonium nitrate added, and the solution made slightly acid by the addition of nitric acid. The

solution was then placed on the water bath at 50° C. and 50–75 cubic centimeters of ammonium molybdate solution added while stirring. If test showed all phosphates precipitated the solution was allowed to digest for two or three hours and then filtered through a prepared Gooch crucible. The precipitate was then washed with cold water until two fillings of the filter did not discharge the color produced by one drop of the standard alkali solution and phenolphthalein. The filter was then returned to the original beaker in which precipitated and the precipitate dissolved in a standard solution of sodium hydroxide, 1 cubic centimeter of which equaled .001 gram of phosphoric acid, and the excess of alkali titrated back with a standard hydrochloric acid solution. The amount of alkali solution used by the precipitate multiplied by .001 gave the weight of phosphoric acid in 4 grams of soil.

Total nitrogen was determined by digestion of approximately 7 grams of the prepared soil sample in a Kjeldahl digesting flask with 25–50 cubic centimeters of strong sulphuric acid and 10 grams of powdered sodium sulphate. After the organic matter had been totally destroyed, the entire contents of the flask were washed into an 800-cubic-centimeter Kjeldahl flask, the solution neutralized, and the ammonia distilled off as usual into a known volume of standard acid and titrated back with standard alkali.

VI. Formation and Composition of Soils

The complex material we call the soil is a widely varying substance. It is only necessary to consider its origin and method of formation to understand why marked differences are found in the soils of neighboring portions of terrain. Briefly stated,

the soil may be regarded as a complex of (*a*) disintegrated rock material, which constitutes the skeleton of the soil; (*b*) the lime salts (carbonate and phosphate) largely derived from marine organisms of an early geologic period; (*c*) the remains and decomposition products of plants which have grown in the soil itself, and constitute the principal part of the organic matter and the chief source of energy; (*d*) the soil water mechanically held, with its dissolved salts and gases.

These ingredients are far from constant in either absolute or relative quantities. Furthermore, the different geologic formations with their varying types of rock structure will yield different minerals as a result of weathering, oxidation, action of water, action of temperature, etc. However, from an agricultural standpoint the different combinations may be characterized somewhat by the relative amounts of the predominating ingredient. Thus we have, according to Russell's classification:

1. Mineral soils, consisting mainly of rock material and comprising sands, loams and clays.
2. Calcareous soils, containing notable amounts of chalk or limestone.
3. Alkali soils, rich in soluble saline matter.
4. Acid humus or peat soils where much organic matter has accumulated in the absence of calcium carbonate.
5. Neutral humus soils where much organic matter has accumulated, but in presence of sufficient calcium carbonate to prevent acidity.

Only rarely is a soil found which is identical in its composition with the rock from which it was derived. The processes of weathering and leaching attack all except the most refractory rocks,

and as a result a mineral soil gradually shades off into a series of grades, from the extreme where the chemical and physical disintegration has been slight and the soil particles are complex in composition to the other extreme where decomposition has been nearly complete and the coarse particles remaining consist almost wholly of silica.

In acid soils the condition of minimum change is predominant, while the coastal plains of the United States exhibit the type in which marked change has taken place. Tropical soils are believed to result from processes of decomposition of a still more rapid character, induced by the constantly high temperature, abundant rainfall with its consequent leaching action, and the great activity of the soil bacteria and other microörganisms which produce reactive substances of solvent character.

Soils which have been derived especially from the weathering of the underlying rocks are sometimes spoken of as *sedentary* and show close physical and chemical relationships to the parent rock. The transition from solid rock or ledge to the broken-down weathered soil can sometimes be observed in railway cuts, quarries and other excavations. Such soils are generally fine-grained at the surface, consisting of small particles of clay, sand and other minerals with numerous stones of more refractory character. The deeper one penetrates into the soil the less disintegration has taken place, the greater the number and size of the stones, until large fragments of practically unaltered rock are found, and these grade insensibly into the solid rock beneath.

On the other hand, many soils show marked differences in character from the underlying rock. These are known as *transported* or *drift* soil, and, as their name indicates, have been brought from other areas and deposited in a layer of varying

depth over the rocks below. Among the agencies acting in transporting such soils are ice (as in the glacial period when glacial drift was widely scattered in North America), wind and especially water.

The action of streams is doubtless at the present time the most powerful mechanical agency in soil formation. This reaches a high degree of effectiveness in the tropics, where the torrential rains swell the small streams to raging rivers in a few hours, and tear away rock masses, soil and vegetation from the upper reaches of the stream and, after grinding and mixing them in transit, deposit a portion of the suspended matter as sand, silt and clay in the bottom lands as the water subsides. This process explains the deposit of the finest material at the lowest levels of the valley while the coarser and heavier masses may be left farther upstream, and is in general the mode of formation of alluvial soils.

Rainfall in itself causes a certain amount of rock decomposition even without the necessity for flooding, since the absorption of carbon dioxide by the rain-water makes it in effect a weak acid. Its most important effect on soils, however, is due to the leaching action and the washing out of very fine particles of silt and clay. It is only necessary to study the analyses of river waters to observe how the ordinary run-off following rainfall contributes mineral salts and organic matter to the streams. When the rainfall is insufficient to bring about this leaching effect, as in really arid regions, the salts are wholly or in part retained by the soil and may later appear as superficial deposits or spots of "alkali." The amount of action thus induced by the physical and chemical forces determines the character of the soil; thus we have the residual or sedentary soils of the high level or

slightly sloped areas, the colluvial soils of hillsides and steeper slopes where material from different rock layers is intermingled, and the alluvial soils of the river bottom lands, deposited as silt and fine material from the streams in flood either in the recent or remote past. These show great variety in chemical composition, and because of their fineness in texture, due to advanced decomposition of the original rock masses, they are generally of superior fertility. Since the size of the particles carried by water depends on the rate of the current, it is possible that two samples of soil taken at different times from the land subject to flooding may have quite different mechanical analyses.

These differences in soil content may be still further augmented by oxidation which affects such components as the iron, and especially in fine-grained soils where the great increase in surface exposed makes it possible for chemical changes to be practically continuous. Vegetation also plays an important part in soil formation and soil change. In soils containing large rock masses, the mechanical action of tree roots splits off fragments of these masses and thus exposes them to weathering. The force thus exerted is frequently very great. Moreover, there is reason to believe that acids (root-acids) are secreted by practically all the growing root-tips, and these exert solvent action on the smaller particles of mineral matter. Finally there is the extensive action produced by the millions of bacteria and other fungi which are constantly developing in the soil, transforming the waste organic matter from dead vegetation into carbon dioxide and other acidic substances and promoting the interaction of organic and inorganic material which it is believed by some is the real basis of fertility. The natural process of decay of roots, stems and leaves brought about in

part by substances in the tissues themselves, but mostly through these microbic agencies above mentioned, leads to the transformation of the tissues into a brownish or black mass known as *vegetable mould* or *humus*. This indefinite complex of decaying organic matter not only gives color to the soil, but it assists in bringing about new decompositions of the rock particles by its acids and the carbon dioxide continuously developed as a result of fermentative and oxidizing changes, and it probably also returns the mineral salts (ash) of the tissues to the soil in a form which the growing plant can utilize readily. Whether the organic carbonaceous material can be at once taken up and used as food by the growing plant is a question requiring more elucidation than now exists, but there seems little reason to doubt that through microbic agencies nitrogenous organic bodies which may be utilized directly or indirectly are formed. That combinations between the humus and salts of lime or iron may take place is probable.

At all events, humus plays a most important part in the soil, as it serves to retain both gases and water, to render the soil porous and "light," thus admitting oxygen penetration to greater depth; it acts as an equalizer of temperature, and it promotes bacterial activity. A good soil, therefore, is generally deep and loose enough to permit extensive development and penetration of roots, porous enough to admit air plentifully and to retain the soil water, and rich enough in organic matter to support an abundant microbic life to bring about the desired chemical changes.

Types of Rocks Forming Soils. In view of the fact that all soils are derived primarily from rocks, a hasty survey of the principal rocks so functioning may be useful. All rocks fall broadly into the following classes:

(*a*) Sedimentary, that is, deposited from water in

a more or less stratified form. These include limestones, sandstones, clays and shales.

(*b*) Metamorphic, or those produced from sedimentary rocks as a result of subterranean heat.

(*c*) Igneous or eruptive, those originally volcanic or ejected from the interior of the earth in a molten state. This group is divided into two types: the acidic, generally light in color and containing a large proportion of free quartz or silica; and the basic, containing little free quartz and dark in color, largely because of iron. The majority of Central and South American soils are said to be of the former, or acid type, although certain considerations would lead us to believe that such a statement is too sweeping and that certain areas contain soils of the basaltic, or basic type. This is evident from the chemical analyses, which in general show generous percentages of lime and magnesia. It is also evident from a study of the geologic maps of the areas here particularly under consideration. While the western or Pacific slopes of the Central American countries show the influence of acidic lavas and are largely underlaid by rocks of this character, the eastern coastal plains and river valleys are more basic in character. In the Guatemala Division (the Motagua valley and its surroundings) there is a much mixed geology; the rocks are mostly old, consisting of decomposed granites, diorites, schists and gneiss, with limestone-bearing rocks relatively few. As a result, we find in this Division a generally low percentage of lime and magnesia. In Honduras, Costa Rica and Panama (Bocas) the rocks are mostly cretaceous or derived from basic lavas. In Colombia the soil is largely alluvial, made up of disintegrated sediments and containing soluble salts, such as sulphates, etc. (alkali). Jamaica is rich in marine limestones pushed up from the sea.

The mechanical disintegration of rocks of crystal-

line structure by weathering, moisture, impact, etc., leads first to separation along the cleavage planes into more or less angular masses of varied coarseness. Later the chemical decomposition takes place. This yields the different classes of gravel, coarse and fine, then, in the case of quartz rocks, the sands, and finally the silts. With soft limestone chemical action takes place in the upper layers of the soil which reduces the stone to a fine silty condition. Sandstones yield pure sands and therefore generally poor soils, or sand mixed with other and more desirable chemical substances, according to the nature of the cement substance which holds the grains of sand together. If this is of silicious character the rock is very refractory and even when broken up yields the poorest type of sandy soil (pine barrens). If the cement substance is ferruginous similarly poor soils are produced, characterized in the temperate zone by scrub oak and dwarf pine. The calcareous and zeolitic sandstones give better soils because they yield salts, lime, potash, etc., needed by green plants, and as the green plants grow and die down, year after year, the "humus" component is formed. Soils which are practically pure sand are loose in texture, have low water retaining power, heat and cool rapidly and are quite unsuited to plant growth in general. Such soils are derived from quartz or flint and are nearly pure silicon dioxide (SiO_2). They are generally somewhat colored by iron, but the individual particles are glassy in appearance and gritty to the touch.

The common clay soils are produced by the breaking down of silicates of aluminum, frequently mixed or combined with silicates of other metals, as iron, calcium, etc. The term "clay" is generally applied to any soil or mixture of soils which is in a finely divided state and has marked plasticity and adhesiveness, although true clay is generally present in

a fairly low percentage (1–5). A clay becomes a "loam" when this property has been largely or wholly lost by mixture with other mineral residues, sand, etc. This explains the varied nature of so-called "clay soils." In pure state, clays have practically nothing of value to the plant, and are sometimes so compact as to restrict greatly the processes of root extension, water drainage and aëration of the soils. Sometimes, however, there is a tendency for the very fine particles of clay to clump together, giving a fairly coarse grain and a pore-space which may even exceed that in certain types of sandy soil. When mixed with lime, magnesia and iron they are tillable, lose some of their objectionable qualities and, if the mixture of lime and sand is sufficient, may bring actual improvement when added to sour lands poor in lime. This effect, due to the lime largely, is an illustration of the beneficial influence which lime seems to exert on agricultural soils in general. This naturally leads to the interesting question—what amount of lime is best for farm soils? Absolute standards cannot be set up, owing to the influence of other elements, and especially clay. Hilgard states that in sandy soils .10% of lime will support the typical lime-loving plant growths characteristic of good soils, while in heavy clay soils it requires at least six times as much lime to produce the same result. Lists of plants, the normal occurrence of which is regarded as significant of good soils, have been compiled in which it is shown that lime is apparently the governing factor. These lists, while useful in the temperate zone, cannot serve in the present study of tropical soils.

VII. Requirements of Plants and their Sources

The factors controlling plant growth are (1) oxygen, (2) light, (3) proper temperature, (4) water supply, (5) food supply, (6) harmful agencies. Of these the first five are necessary for development of the plant and control naturally the character of the vegetation in different parts of the world. In the tropics the first three of these factors operate at what might be called a favorable concentration, and apparently bear no direct relation to soil conditions, except in so far as they affect the soil temperature or interfere with the exchange of gases by which a suitable soil ventilation and adequate oxygen supply to the roots are obtained. On the other hand, water supply and food supply are closely bound up with the physical and chemical character of the soil. The water requirement of plants may be markedly affected by the character of the soil. Too great looseness leads to rapid drying out. Too great density and compactness, as in pure clays or lands having an excess of clay, may so prevent proper drainage as to cause the formation of destructive or toxic substances by anaërobic organisms, in addition to the direct shutting off of the oxygen supply, as has been stated.

Up to a certain point, crop production increases with increasing water supply, but beyond the optimum (which is specific for each plant rather than general) there is a falling off in yield. It has also been noted that as food supply increases the water requirement is lessened, that is, apparently a smaller amount of concentrated soil water is required to secure the necessary salts for cell sap, fruit and seed than when the mineral solutions are of great dilution. That the amount of water sup-

ply is of great importance in determining the character of the plant, time required for maturing and character of the fruit or grain, is undeniable. This is a very practical matter in regions requiring irrigation, but throughout the greater part of Central America the question of water control rather than water supply is the perplexing one.

This brings us to the fourth factor—that of food supply. As with all other types of living things, food supply is the principal dominating factor which controls growth and productivity. Especially is this the case in the tropics, where the physical environment of the adapted plants is highly satisfactory. It is assumed that the food requirements of tropical plants are essentially the same as for others. Little has been written giving special knowledge of tropical soils, so almost all available data and statements bearing on plant food requirements have been obtained in the temperate zone. The same is true of figures for analysis of soils. A few analyses of Hawaiian soils have been made, and we have also some data on soils in Madagascar, Kamerun and other tropical regions, but their number is relatively small. We get our first knowledge of food requirements by considering what elements actually enter into the composition of plant tissues. Since the structure of the plant is largely made up of carbon, hydrogen, oxygen and nitrogen, these may be regarded as the four principal food elements, and combinations containing these elements must be supplied to the plant. Other materials, although used in small amounts, are equally important, since the plant cannot grow without them. In reality, the plant manufactures its own food from materials taken from the air and the soil. What we ordinarily call plant foods are therefore merely the raw materials which the plant synthesizes in its own way. These raw materials consist of carbon dioxide,

water, oxygen, certain compounds of nitrogen, phosphorus, sulphur, calcium, magnesium and iron, and probably also sodium, silicon and manganese. Hydrogen and oxygen are largely derived from water and air. Water and oxygen have already been mentioned in another connection, but in addition it may be stated that these both enter into the structural or synthetic work of the plant in the increase of tissues, leaf, stem and fruit, but their connection with the soil composition is only indirect. In the following pages I have endeavored to give an idea of the significance of the different elements or compounds required by the plant and thus demonstrate the reason for making an analysis for each of the ingredients sought.

Carbon. Carbon is largely derived from the carbon dioxide in the air and the same gas as it is evolved in the decomposition of organic matter in the soil. The carbon dioxide in the air is a somewhat variable quantity, since it depends largely on the intensity of biological or bio-chemical action. Brown and Escombe found that the amount of carbon dioxide in Kew Gardens varied from 2.43 to 3.60 parts by volume in 10,000 parts of air, the average being 2.94. No correlation of carbon dioxide and crop yield has been investigated, so far as I am aware, but Russell suggests that undoubtedly growth of plants would respond to variations of this sort in a generally quantitative way. Data are not available on the carbon dioxide content of the air in the tropical areas subject to cultivation with bananas and other crops, but it is probably considerably higher than in the temperate zone. Since a portion of the carbon dioxide is produced from the organic matter decomposing in the soil, the amount of this organic matter is roughly a measure of the food value of the soil for this particular element. That this measure is far from quanti-

mineral is set free as simple salts. This represents the condition of the third class. The fourth class represents by-products which are incapable of further change in the soil.

As pointed out by Russell, the result of this series of decomposition processes taking place in the soil is to give a mass of material of varying character, but with certain fairly fixed properties.

1. It gives a dark brown or black color to the soil.

2. It can fix or precipitate certain mineral elements, or ions, from their solutions and so prevent loss by leaching.

3. It causes a lightening of the soil and so leads to improved tilth and workability. Obviously an excess of organic matter is possible, especially when the material is difficultly broken down, as with sawdust and similar cellulose compounds.

4. It increases the water-retaining capacity of the soil and modifies, or in large percentages may obliterate, the characters usually imparted by gravel, sand or clay.

Thus soils having a high organic content sometimes counterbalance the objectionable effect of the fine silt or clay. This condition is found in the productive prairie soil of the Red River Valley in Manitoba, which has mineral composition identical with certain barren soils in England, but has 26% of organic matter as compared with 5–8%.

5. The decomposed organic matter swells when wetted.

6. It is fairly permanent, and when such an organic layer has been formed it disappears but slowly, unless exposed to the conditions

of high temperature and extreme dryness. Furthermore, it disappears more rapidly from open soils than from compact loams and clays.

These properties greatly increase the fertility of the soil, hence the desirability of a constant supply of raw material in the form of leaves, stems, grass and other decomposable material.

The name "humus" is given to this mass of organic matter in the different states of decomposition. Some attempts have been made to distinguish definite products under this name, but it seems wiser to use the term in the collective sense and not to try to make special and difficult analyses for a hypothetical compound which has no sharply determining features. It cannot be assumed, however, that the humus of soils is always identical in composition. Humus is not devoid of nitrogen, but contains it in varying percentages, according to the origin of the material. Different observers have analyzed the organic material obtained by extracting soil with alkalies and have found from 3 to 10%. In the work at Rothamsted, England, it was found that about half the total nitrogen was soluble in alkalies, and the other half insoluble, no matter what the origin of the organic matter, and that the removal of the alkali-soluble portion did not lessen the productivity of the soil. It is probable that the nitrogen in the humus is only of importance in so far as it can be transformed into ammonia and nitrates and thus become immediately available for the green plant.

Nitrogen. We may now consider briefly the relation of soils to nitrogen. All plants require nitrogen for the building up of cell contents. As above explained, a portion of the nitrogen of soils is obtained by the process of humification. The

remainder comes from animal sources and from the air. Analyses of soils have shown that arable soils contain usually about 0.10–0.15% and that this amount will support plant life. Cultivated soils may contain considerably more or even several times this amount. Nitrogen occurs in the soil principally in the form of combined organic nitrogen, nitrates and free ammonia. The last named is found in very small amounts (ten parts per million), as, if it is not seized by the green plant, it is quickly oxidized to nitrates or is leached away. Nitrates also are very variable in amount, as they are quickly taken up by plants, lost by action of rain, or reduced by bacterial action. On the other hand, they are constantly being re-formed also by bacterial action (nitrification).

Since these modifications of nitrogen are so variable, and to some extent interchangeable, and subject to great fluctuations, it seems necessary, in soil analyses, to measure only the total nitrogen, since this represents the potential nitrogenous food. The ammonia and nitrates rarely make up more than 1% of the total nitrogen in the soil, the remainder being in the combined forms of proteins, amino-acids, etc.

Ammonification and Nitrification. These combined processes bring about one of the most fundamental bio-chemical changes taking place in the soil. Briefly stated, nitrification (as the whole process is ordinarily included under one name) may be described as the transformation of the organic wastes containing nitrogen through the digestive activity of micro-organisms in the soil. The insoluble plant and animal protein nitrogen is thus broken down into decomposition products of relatively simple composition, finally yielding ammonia, which in the soil solution at once forms carbonate of ammonia.

Nitrification. The oxidation of this ammonium carbonate by other groups of bacteria to nitrites and nitrates is then accomplished in a succession of steps. This process goes on in all fertile soils and is limited only by inadequate water supply or the presence of harmful substances, such as acids, or temperatures which are either too hot or too cold to permit bacterial multiplication. When the leaves and stems of plants decay, or when nitrogenous substances of animal origin, such as dried blood or stable manure, are added to the soil, changes begin at once either through the activity of the organisms in the soil or in the organic matter itself. This may most easily be illustrated by the changes taking place in stable manure. Here through the activity of a group of very abundant bacteria in the material itself the waste nitrogen products, of which urea is a type, become hydrated, or take on water, whereby they are changed to ammonium carbonate. This ammonium carbonate is in part acted upon by the weak organic acids in the soil with the formation of other ammonium salts, but is in general attacked by another group of micro-organisms, known as the nitroso-bacteria, which split the ammonium salts and oxidize the ammonia by means of the oxygen in the air to the condition of nitrites. Bacteria thus serve as carriers of oxygen from the air to the organic material, hence this process can only go on in the upper layers of the soil where there is contact with atmospheric oxygen. The nitrites, however, are not persistent, but, on the other hand, are extremely transitory, and it is practically impossible to get any marked accumulation of nitrite in the soil.

The presence of nitrites can be detected by certain very delicate color tests, but the analysis of the soil for nitrite is impracticable and unimportant

because the amount which is normally found is so small that it would be expressed only in parts per million rather than in percentages. Furthermore, the nitrite is of no importance from the standpoint of agriculture, except as an intermediate phase in nitrogen transformation, since the green plant is not able to utilize the nitrogen in this form, but only in the forms of ammonia and nitrates. The formation of nitrites is therefore only an intermediary step in the complete oxidation, or *mineralization*, of the nitrogen. The nitrites are again attacked in the presence of moisture by another group of bacteria, known as the nitro-bacteria, and these bring about further combination of the nitrogen with the oxygen of the air, resulting in nitric acid, or, as actually occurs in the soil, in the salts of nitric acid, all of which are soluble and which can be absorbed by the root-hairs and thus brought into the water-conducting tissues along with other food materials. Here the synthetic power of the organism is exerted on the combination of nitrate, sugar and various other salts which are present, and the complex substance which becomes the sole content of the living plant is built up. The upper layers of the soil constitute, therefore, a chemical laboratory in which decomposition and oxidation are constantly going on and follow one another in rapid succession. In the state of nitrates the nitrogen has become entirely mineral in character. After the action of the synthetic enzymes of the green plant, this mineral material, along with the other food substances, is transformed into living organic matter through the growth processes of the plant. This organic matter eventually becomes lifeless and returns to the soil still organic in character, or, if the plant is used as a food for herbivorous animals, it goes through still further transformations in the intestinal tract of the animals

and is eventually excreted in the form of lifeless organic matter mixed with mineral salts, bacteria, water, etc. As soon as it reaches the soil the decomposition and oxidation processes begin again. Therefore we have the possibility of the same nitrogen being returned to the soil time after time and utilized over and over by green plants as a portion of its food supply. It is to this succession of changes—whereby we get living matter transformed to lifeless organic, lifeless organic to mineral and mineral back to living organic—that we give the name of the "cycle of nitrogen." The actual nitrification itself consists in that portion of the cycle by which the dead waste material is mineralized with the formation of nitrate.

Denitrification. This is not, however, the only change taking place in nitrogenous material in the soil which is of importance in agriculture. A process almost the reverse of nitrification and consequently known as denitrification is also possible and frequently takes place. This is brought about through the agency of still another group of microbes whose function is to remove oxygen from the mineralized material and to break it down so that much of the nitrogen escapes as free gaseous nitrogen. Obviously this is a process of objectionable character and this is one (and perhaps the main) way by which virgin soils lose their nitrogen after cultivation has been started.

The two processes, nitrification and denitrification, may go on in the same soil side by side, depending upon the conditions of temperature, aëration, character of the organic matter and specific character of the germs present. If the sum of the oxidizing processes exceeds those of the denitrifying processes, as is usually the case, there will be a gain in the plant food in the forms of ammonia, and especially nitrates. Should it hap-

pen, however, that the denitrifying processes are in the ascendant, the food supply for the green plant gradually diminishes and nitrogen starvation is possible. It is known that both these types of processes take place in tropical soils, although the exact conditions under which they go on have not been worked out. It is also known that organic matter in tropical soils may suffer serious depletion during periods of drought and extreme high temperature, and it is conceivable that during these periods bio-chemical changes analogous to denitrification are going on most rapidly.

Nitrogen Fixation. The process of nitrification is not the only means by which nitrogenous food is produced in the soil. Another bio-chemical change to which the term "nitrogen fixation" has been given is now known to be characteristic of soils in many parts of the world. Nitrogen fixation means, as its name implies, the collection of free gaseous nitrogen from the air and its fixation or combination with certain substances in the soil. The agency by which this is done was for many years unknown, although the fact that certain crops were actually nitrogen gatherers had been established. When it was discovered that plants of the leguminous type, such as the pea, bean, clover, alfalfa and peanut, were able by symbiosis or coöperative living together with certain species of bacteria to form nodules on the roots, and through the activity of the combined organisms could collect and assimilate free nitrogen, the explanation of the process of fixation was advanced one step. Even now it is not known exactly how the nitrogen is absorbed or in what combinations it exists in the plant. It has been fully demonstrated, however, that great increases in the nitrogen content of the plants of this family are thereby brought about. The process of green manuring,

as it is sometimes called, by plowing under either the stubble of these plants or the whole plant itself, is therefore a simple means of increasing the nitrogen content of the soil, making it possible for the process of nitrification to work over this material and bring it eventually to the condition of nitrates. Thus the crop rotations in which a legume is used as one of the crops are of very great advantage since thereby the other crop can make use of the nitrogenous food which has been stored by the legume. More recently, another type of nitrogen fixation has been discovered. This does not involve symbiosis, or the combination of the green plant with the bacteria, but depends simply on the activity of certain groups of organisms which have been found to be generally distributed in good soils. One of these, to which the name *plastridium* has been given, lives particularly in the lower layers of the soil from two to five feet below the surface, where the amount of free oxygen is limited. The amount of actual nitrogen fixation produced by this type of microbe is small because of the low percentage of organic matter which supplies the energy for the organism and also because of the low nitrogen concentration at such depths. The second type, to which the name *azotobacter* has been given, is an aërobic, or air-loving form living chiefly in the top six to eight inches of the soil where the organic matter is most plentiful and the air concentration is fairly high. These aërobic forms fix from eight to twelve times as much nitrogen per unit of food material used up as do the deeper-seated anaërobic species. The chemistry of this type of nitrogen fixation is still but little known. It is certain that there must be an abundance of decomposing organic matter, since carbon contained in such material is the chief source of energy for this class of bacteria. Other desirable

conditions are thorough aëration, that is, a loose structure, suitable temperature and moisture conditions and the alkaline reaction of the soil. The main value of allowing land to lie fallow after having been cropped for several years is apparently due to these non-symbiotic nitrogen fixers. Both types of nitrogen fixation, that is, the symbiotic and the non-symbiotic, should be regarded as essentially related to the general cycle of nitrogen, and it is probable that without such fixation the combined nitrogen would gradually be dissipated and lost to the soil.

Since the total nitrogenous food for the plant found in the soil is the algebraic sum of all these processes of fixation, nitrification and denitrification, it is not surprising that soils vary greatly in their nitrogen content and that it is difficult to establish fixed values or limits for nitrogen in fertile soils.

Of all nitrogen compounds investigated, nitrates are the best, and in natural conditions probably the only nitrogenous foods for non-leguminous plants. Ammonium salts in dilute solution are also available, but are not regarded as so generally desirable as nitrates. In fact, some authors suggest that plants supplied exclusively with nitrogen in the form of ammonium sulphate exhibit "nitrogen starvation," a condition marked by lack of growth, yellowed leaves and a general stunted appearance. Nitrates seem to give special stimulation to the leaves of plants. An excess of nitrates may, however, lead to structural weakness with some plants (as grains) and does not cause increased fruit production in like ratio. However, in general, where there is much rainfall an excess of nitrate is almost unthinkable, as nitrates are known to leach away rapidly, and this loss may exceed the production by nitrification.

It has been proved that virgin soils may lose a

portion of their nitrogen by cultivation, this loss being due not to the removal with the crop but to the leaching out as a result of soil disturbance, and of the denitrification produced by bacteria, by which free nitrogen is set free in gaseous form. On the other hand, land well covered with vegetation tends to show a gain, especially when lime or calcium carbonate is also present, and gains are also made when rotation of crops is carried out, especially with leguminous plants. Denitrification takes place, especially in poorly aërated, water-logged soils which have heavy working properties. In good arable soils, therefore, we should not expect large losses from this source.

Comparatively little work has been done on the transformation of nitrogen by fixation, ammonification and nitrification in tropical soils. The evidence from actual studies indicates that both symbiotic and non-symbiotic nitrogen fixation takes place readily in soils which are not acid and which contain organic matter. Burgess has clearly demonstrated that all these processes go on in Hawaiian sugar-cane soils, and has arrived at the conclusion that neutralizing soil acidity always tends to promote nitrification. Since lime is the most available material for such neutralization, the beneficial effects of lime either naturally present or added as a fertilizing agent are evident.

What the effect of continued high temperature may be on the processes involved in these changes in nitrogen is still in need of thorough investigation. It is clear that the nitrogen in soils will vary greatly, according to the character of the organic matter, the amount of nitrogen fixation taking place, the amount of nitrification and denitrification, the rainfall, the compactness of the soil (favoring or preventing aëration) and the alkalinity of the soil. In view of this large number of variables it is impossible to

say that one soil having twice as much nitrogen as another is twice as good. It is the availability of the nitrogen that is of importance. This means the amount of nitrification that can be induced by the organisms in the soil. Hilgard is of the opinion that the necessary percentage of nitrogen in the humus is about 4% and that the remainder of the needs of all vegetation will be supplied through the natural changes in the soil, but there is no fixed ratio between the nitrogen of humus and total nitrogen. On the whole, percentages of total nitrogen above .25%–.40% may be regarded as highly satisfactory, while those below .15% should be regarded as below normal and unsatisfactory.

Phosphates. These are the best sources of phosphorus for plants. They occur especially as phosphates of lime, magnesia and other bases. In soil analysis their amount is generally expressed in terms of phosphoric acid anhydride (P_2O_5).

The effect of phosphorus is to promote root formation and especially the lateral roots, thus improving the general nutrition of the plant, and hastening the ripening or maturing processes. With clay soils the effect on root development is of great value. All shallow-rooted crops are improved by phosphates, and this is especially the case in dry countries or in periods of drought.

Phosphate starvation is generally first shown by diminution of the leafage and stem, but there are no marked symptoms as in nitrogen starvation.

The exact function of phosphoric acid in plant nutrition is difficult to state, but apparently it is one of those substances which must be present, even in very minute amounts, if growth and cell division are to take place and if starch is to be transformed to sugar.

There is apparently no marked difference in

amounts of phosphoric acid in arid and humid regions, and it is not much depleted by leaching. When it occurs in combination with iron (ferric hydrate) or aluminum hydrate, it forms a nearly insoluble material which is apparently entirely unavailable for plant use. In Hawaiian volcanic soils this is notably the case. Here, although analysis shows a very high phosphoric acid content, experience shows that the great need of the soil is phosphate fertilization.

The requirements of vegetation are generally fully met when the soil contains .10% phosphoric acid, and .25% is considered high. With a large supply of humus in the soil, or a high percentage of carbonate of lime, a low percentage of phosphoric acid is effective, as apparently these compounds bring about greater availability in some manner. Where much iron exists in the soil the addition of Thomas slag or bone meal is the best form of treatment to increase phosphate content.

Wohltmann gives the following data as serviceable in judging tropical soils:

Phosphoric Acid

.20%	very rich
.10%	good
.06%	inadequate

The first of these figures would not apply in a soil high in iron or aluminum.

Potash. This mineral is necessary for all green plants, as it seems to have a direct relation to the formation of starch. It is therefore of great importance to all plants with starchy fruits, as the banana, and its deficiency leads to stunted development of fruit or grain. Plants suffering from potash starvation are poor or dull in color and tend to be weak. Their leaves often die early at the tips.

On the other hand, with certain plants there is distinctly greater resistance to fungus diseases and to the ravages of eelworms, etc., when potash is abundantly supplied. Potash may be in part but not entirely replaced by soda, and soda always brings improvement when there is a deficiency of potash, but it cannot prevent potash starvation completely.

Tropical soils contain varying amounts of potash, and there is some difference of opinion as to what is adequate. Wohltmann regards .20% as rich and .05% as inadequate, while Hilgard places the figures for the same ratings at above .45% and below .25% respectively. Some of the richest Hawaiian soils contain relatively low percentages (.12% to .24%) but of high availability.

Most arid soils are relatively rich in potash and need little if any fertilization with this mineral. On the other hand, humid soils and those subject to leaching by heavy rains are likely to need potash before any other chemical. In the cultivation of bananas and cacao, potash is of much importance, as the fruit takes away annually a considerable store of this element and little is left behind in leaf and stem returning to the soil. Potash is generally the first need of these crops when they cease to be productive.

Lime. Calcium, like potassium, is an essential plant food, and occurs in greater quantity in the foliage than in fruit or seed. Plants grown in soils or water devoid of calcium salts have reduced rootage, and have greatly reduced vigor. The most important use of lime salts is apparently to neutralize acidity and to counteract the effect of excessive amounts of saline matter. Whereas single salts of potassium, sodium, magnesium and other metallic elements are toxic to plants, mixtures of their salts are not poisonous. Lime salts es-

pecially reduce this toxic effect. They also promote cell division and growth, and particularly promote strengthening of the cell walls. These facts do not adequately explain the rôle of lime in increasing soil fertility, for, as has already been stated, lime soils are notably productive.

Hilgard has shown by comparisons of soils with high and low lime percentages from Mississippi and California that high lime content seems to make it possible for soils to continue fertile for years even when potash and phosphoric acid are so low as to be generally regarded as inadequate, while, on the other hand, soils fairly high in phosphoric acid and potash but low in lime quickly become unproductive until lime is introduced, when productiveness is rapidly restored.

In sandy soils a small amount of lime (.10% to .20%) will produce good growths of the "calciphile" plants, while with heavy clays this figure must be at least six times as great to bring about the same result. The typical dark-colored humus characteristic of calcareous soils does not appear in clay lands until the percentage of lime is approximately 1%, while in sandy lands .20% is sufficient. The table given on page 44 is quoted from the work of Professor Maercker of Halle, Germany, as a fairly satisfactory means of rating the quality of soils from the chemical analysis.

The methods of preparation of the soils for analysis may have given results lower than would have been obtained by the methods we have used in this work, but in general the results seem to be in line with accepted views of soil chemists.

Investigations in several widely different areas have indicated that the data on lime accepted for the temperate zone may not be entirely applicable in classifying tropical soils, but nevertheless all the figures seem to point to the desirability of carbonate

RATING OF SOILS BY PERCENTAGE OF PLANT FOODS FOUND

Grade of soil	*Potash*	*Phosphoric acid*	*Lime*		*Total Nitrogen*
			Clay soil	*Sandy soil*	
Poor	below 0.05	below 0.05	below 0.10	below 0.05	below 0.05
Medium	0.05–0.15	0.05–0.10	0.10–0.25	0.10–0.15	0.05–0.10
Normal	0.15–0.25	0.10–0.15	0.25–0.50	0.15–0.20	0.10–0.15
Good	0.25–0.40	0.15–0.25	0.50–1.00	0.20–0.30	0.15–0.25
Rich	above 0.40	above 0.25	above 1.00	above 0.30	above 0.25

of lime in the soils used for tropical agriculture. Wohltmann regards soils having 1% of lime and magnesia with proper balance in potash, phosphoric acid and nitrogen as being rich, while half this amount would be classed as good. However, a large excess of carbonate of lime (8% to 20% or more) is objectionable as it disturbs the general nutrition of plants. Amounts up to 2% may be regarded as satisfactory. The total effect of lime in soils is unknown, but the principal chemical advantages which seem to result from its presence in soils may be summarized as follows:

1. Neutralization of soil acidity.
2. Promotion of nitrogen fixation and nitrification.
3. Liberation of potash and phosphoric acid.
4. Fixation of humus.
5. Counteraction of excessive magnesia.
6. Counteraction of "alkali."

Magnesium. Although showing many affinities with calcium, the two elements are not mutually replaceable in plant foods. Magnesium seems to be essential for good chlorophyll development, and also for the formation of oil by plants. In the matured plant it is found especially in the seed or fruit rather than in the leaf and stem, being like phosphorus in this respect, and unlike calcium and potassium, which are especially found as constituents of stem and leaf rather than seed.

An excess of magnesium salts in soil is harmful, as a result of the toxic effect due to overdose, but this can be mitigated by lime. Soils high in magnesia but low in lime are therefore likely to be unsatisfactory, especially if the salts present are sulphate or chloride. The carbonate is much less objectionable. Magnesium salts lead to an increase

in available potash in the soil by slowly replacing it in the salts with which the potash is combined. There is much difference of opinion regarding the desirability of a ratio of lime to magnesia, but the latest work on soils shows that very good and very bad soils may have practically identical ratios. On the whole, magnesian rocks are not to be regarded as good soil-formers, and an excess of magnesium over lime, although frequently observed, is, however, injurious in the long run to most crops.

Tropical soils, however, very frequently show that magnesium exceeds lime in actual percentages, a fact which is explained by the greater solubility of lime salts in carbonated water and the consequent leaching out. This does not seem to be an entirely adequate explanation in many instances. It is probably true that when the amount of magnesia is considerably greater than that of lime the lands tend to become unproductive in a relatively short time, but it is difficult to establish any fixed ratio of lime to magnesia, as 2 : 1 or 3 : 1, as has been suggested, which will be satisfactory in all instances. Some Japanese work has shown that when the ratio is 1 : 1 rice and oats do very well, while with buckwheat a ratio of 3 : 1 is superior. The consensus of opinion is that the lime should exceed the magnesia and preferably be much larger in order to neutralize the toxic effect of the magnesium salts and at the same time take care of the soil acidities.

Iron and Aluminum. Iron is an absolute necessity for the formation of chlorophyll. All soils, however, contain iron in some amounts and generally in such combinations that when acted upon by a soil water or carbonated water soluble ferric salts will be produced. It is unnecessary therefore to introduce iron into the soil. Excessive amounts of iron are undesirable because of the danger of combination with phosphoric acid, producing

insoluble ferric phosphate, which is absolutely unavailable as plant food. With the iron there ordinarily occurs a certain amount of aluminum, and this metal is always present in large amounts in clays. The silicate of aluminum, if very abundant, gives a heavy, difficultly working soil and interferes seriously with the aëration and root formation by the plant.

VIII. Significance of Soil Analysis

Some difference of opinion exists as to the actual significance of chemical examination of soils, and some chemists have even gone so far as to say that the soil analysis throws no light on the question of the fertility of the soil. This is not entirely the case, although it is partially true. The chemical analysis of soils is a means of determining what may be called the permanent producing value or the power of continued production rather than an attempt to show the immediate producing value in any particular year. This is a most important distinction to be drawn and one which should not be overlooked. From this viewpoint the analysis of virgin soils or new lands which have not been cropped continuously for many years becomes of special significance, since it gives an indication of the probable durability, other things being equal, of that particular soil as a crop-producer.

What we speak of as the plant foods of the soil are, as already has been stated, not the immediately available foods which the plant can instantly take up, but rather the reserves which the plant attacks gradually and which are therefore to be considered as distributed over a considerable period of time. This applies especially to the mineral foods with the exception of ammonias and nitrates. These salts together with the organic matter vary in amount

from year to year because of their peculiar methods of formation and do not depend upon the decomposition of rock mass or of special salts in the soil. With the exception of these food substances which I have just mentioned, it becomes of some interest to consider the actual amount of the so-called plant foods occurring in any particular soil and to compare this amount with the amount annually taken away by the crop. Direct computation, using these two figures as numerator and denominator respectively, will show the potential durability of the soil or the length of time which the land may be expected to be productive, assuming that the processes go on by which all these plant foods can be made available.

Leaving out of account the organic matter, the specific gravity of the different soil constituents is practically the same. The true clays or clay-forming substances, such as kaolinite, are the lightest, with an actual specific gravity of about 2.6, then follow feldspar (sp. gr. 2.62), quartz (sp. gr. 2.65), calcite (sp. gr. 2.72), and finally, mica and hornblende with specific gravities varying according to the iron up to something over 3.0. The different soil ingredients are therefore seen to be much the same in actual weight in the mass. The actual weight is, however, much less important than the volume weight. By this we mean the weight of the weathered soil as compared with an equal bulk of water. A cubic foot of water weighs 62.5 pounds, a similar volume of dry soil weighs more, except in case of peaty lands which, when dry, may be actually lighter than water. These may weigh as little as 30 to 50 pounds, while a soil composed almost entirely of the heavier minerals may weigh as high as 100 to 110 pounds per cubic foot. As fair figures, it may be assumed that arable loams weigh generally from 80 to 95 pounds per cubic foot; heavy

clays, that is, those difficultly worked because of the stickiness of the mass, 70 to 75 pounds; forest soils and rich garden soils containing organic matter in considerable amounts, from 66 to 70 pounds per cubic foot. The practical importance of this is seen when we consider the actual analytical figures obtained in the chemical examination of the soil and from that estimate the potential plant food per acre foot. By an "acre foot" is meant the quantity of soil contained in a plot of ground having the area of an acre, that is, 43,560 square feet and a depth of one foot, or 43,560 cubic feet of surface soil. The top foot is the one to be most considered in this respect, since here the changes due to weathering, aëration and the action of microbes, earthworms and other agencies is most marked, and furthermore because this is the particular part of the soil which feeds the growing plant in the highest degree. On the basis of the figures given it will be at once seen that an acre foot of soils of different characters will vary somewhat in weight. In sandy soils the weight per acre foot is generally assumed at 4,000,000 pounds; for loams, 3,500,000; for clay lands, 3,250,000; and for garden or forest lands rich in humus, 3,000,000. Peaty lands or reedy swamps which have been made up very largely of organic matter gradually decomposing, run from 2,000,000 to 2,500,000 pounds per acre foot. Subsoils are heavier than top or surface soils, since they contain less organic matter and much smaller amounts of pore space or air space between the individual soil particles, and because they are subject to greater compression from the weight of the material overlying them. This pore space, as it is called, is not entirely filled up with air under ordinary conditions, as each individual particle of soil is surrounded by a film of organic matter in which the bacteria are resident and by a film of moisture.

This water thus surrounding the particles is what is sometimes spoken of as soil water and in composition is actually a solution of salts which have been absorbed out of the decomposing mineral material by the carbonated water in the soil. It should be borne in mind, of course, that the soil water is carbonated or has absorbed carbon dioxide so that it is actually a weak acid in character, and as such has considerable solvent action upon the mineral which appears in the decomposing rocks. In fact, this carbonated soil water has been called the universal solvent for rock materials. With rocks of alkaline character this acidity is quickly neutralized, but with renewed rainfall or water drawn by capillary action from below, and absorption of fresh carbon dioxide from the air and from the soil, the solvent action of the soil water is likewise renewed and is practically continuous. By means of this solvent action of the soil water we get what may be described as the available plant food existing in a soil at any particular time. This available plant food simply means the salts of potash, lime, magnesia, phosphoric acid, etc., which can be directly absorbed through the roots of the plant or made absorbable by bio-chemical action. A distinction must therefore be always kept in mind between the potential plant food of a particular soil and the available plant food. We know, for example, that if soluble phosphates are added to soils these phosphates do not remain in soluble form continuously in the soil, but become reverted or insoluble through interaction with other soil ingredients and so are transformed in a very short time from available plant foods to potential plant foods. From the reverted form they are gradually changed back through the action of the soil water, acids produced by microbic action and by root action, to available material. Hence it is that the application of arti-

ficial fertilizer, instead of producing quick and enormous stimulation of the plant, is more likely to have the effect of a somewhat increased food supply extending over a considerable time. Right here the statement may be interjected that if the soil itself contains sufficient quantities of any plant food the introduction of much larger amounts of this material in the form of artificial fertilizer does not bring about improved nutritional conditions in the plant. The soil analysis is therefore of very great importance as indicating which particular kind of plant food is abundant and which is scanty in any given soil.

Having seen now that the action of the soil water is one of the factors that brings about the transformation of potential into available foods, it may be of interest to estimate the amount of potential foods in certain kinds of soil. For example, the average percentage of potash found in the soils of Costa Rica which we have analyzed was .34. Assuming now that these soils may be regarded as having an average weight of 3,500,000 pounds per acre foot, there are approximately 11,000 pounds of potential potash found per acre in this Division, or an amount which would be sufficient for a large number of crops of bananas, as indicated by the actual analysis of the banana itself. Similarly, there would be found approximately 14,500 pounds of phosphoric acid per acre. When we estimate the total amount of potential plant foods in this way we find that many soils which give apparently low or poor analysis actually do contain very large quantities of the materials which the plant can sooner or later utilize. It is not, however, to be assumed that all the material which is present and which we call potential plant foods will actually be so utilized, as there are other forces at work tending to lock up some of these mineral salts in the form

of insoluble or undecomposable combinations, and under these conditions the amount of available material is of course considerably reduced. Thus, for example, phosphoric acid may be precipitated by means of iron salts in the soil so as to form an insoluble ferric phosphate which apparently never becomes available as plant food. Therefore those soils which have large amounts of ferric oxide or carbonate may frequently require the addition of fertilizers containing available phosphates even though the chemical analysis of the soil shows some phosphoric acid to be originally present. Hopkins estimates that 2% of the nitrogen, 1% of the phosphoric acid and ¼ of 1% of potash can be made available during one season of farming. Expressed in those terms it is seen that the actual amount of available potash per acre for the Costa Rica Division amounts to only about 30 pounds per year and the phosphoric acid to about 145 pounds. It must be stated, however, that Hopkins' figures are based on results obtained in the examination of soils in the temperate zone and that tropical soils may vary greatly from these in their behavior. Assuming these figures to be reasonably accurate for tropical soils also, we may recast our figures based on the analysis of the crop. If an acre of bananas yields yearly 200 marketable bunches of bananas having an average weight of 60 pounds, we thus have 12,000 pounds of fruit taken away. Now it has been learned by analysis that the mineral salts of the banana amount to about .75% of the weight, or a total of 90 pounds per acre per year. Of the ash, approximately 45% is potash, or a total potash removal of approximately 40 pounds yearly, or more than would be secured according to Hopkins' method of estimation. In other words, those lands which yield less than the requisite amount of potash will soon show signs of potash starvation, the

plants will be reduced in vigor, and the productivity, which for a few years may be maintained at a high level because of the occurrence of an excess of available food, will soon drop to a lower level.

In the tropical soils it is probably true that the transformation from potential to available plant food may take place more rapidly than in the soils of temperate zones because of the continuous action of *all* the agencies affecting it. On this point we have no accurate data from which to draw conclusions. On the other hand, there is one factor which tends to reduce the available plant food in the form of soluble salts, and this is the leaching action which goes on especially rapidly as a result of the high rainfall. On this point also we lack reliable data for tropical conditions, but we know the action in certain seasons must be practically continuous and the losses very large. The losses will be greatest in the most soluble constituents; thus the alkalies, soda and potash will be rapidly washed away, lime less rapidly and magnesia still less rapidly. This helps to explain the higher percentage of magnesia in certain cases where the soil is made up in part of disintegrated minerals containing both these alkaline earths. A good example of this intense leaching effect is found in the Hawaiian Islands, where the black lavas have been decomposed and the soluble salts largely removed while the iron has been left behind in percentages almost sufficient to regard the soils as iron ores. The phosphoric acid, which is abundant in the original rock, is reduced to almost total unavailability by combination with the iron salts, so that phosphate fertilizer is actually needed to secure fertility in these soils.

IX. Observations on Tropical Soils

While no extensive and really comparable analyses have been made on tropical soils from different parts of the world, certain observations bearing directly on the results of analyses have been made which may be useful. It is noted, however, that the methods of analyses vary considerably, and that data of interest is frequently lacking. The most important general conclusions as to tropical soils, that is, the conclusions which have been independently expressed by all the observers, may be summarized in a few brief statements.

1. The agencies of soil formation and decomposition operate in tropical soils more intensively and more continuously than in soils of temperate zones.

2. This action permits the stores of plant food to be set free or changed from potential to available food more rapidly than in temperate climates. This is especially true for regions having heavy rainfall.

3. Tropical soils should be rich in humus when the periods between rainy seasons are not too long, so as to permit the rapid oxidation or burning out of the organic matter.

4. Leaching effects are intense in regions having heavy rainfall.

5. The red "laterite" soils common in the tropics are not always characterized by excessive iron.

6. The plant food percentages of tropical soils are generally low, but the soils are likely to be quite lasting even without fertilization, probably because of the continued rock decomposition, nitrification and changes in organic matter.

7. It is probable that for crops requiring so much potash as do bananas and cacao the first need in the way of artificial fertilization will be potash.

Standards for Soil Analyses

Great difficulties are encountered in attempting to fix definite standards for the chemical ingredients of what may be called good soils. This is in part due to the great physical differences in the character of the soils as manifested in the mechanical analyses, and in part to the chemical composition of the ingredients, or the combinations in which the mineral components originally occur in the soil. In fact, a number of soils may show almost identical analyses and yet differ radically in their productivity.

The depth of soil exerts a great influence on fertility and continued productivity. A deep soil may show a relatively low analysis but possess high productive capacity because of the vast storehouse of materials which are constantly brought to the surface layers by soil water through capillary action, and because of the ease with which the roots of plants may penetrate to great depth.

No satisfactory method of determining the immediate productivity has been devised, although the analyses give pronounced indications of whether or not a soil is likely to be productive. According to Hilgard, virgin soils which show high percentages of the so-called plant foods are likely to respond quickly to cultivation and to show continued productivity. The analyses of two types of soils which he regards as the highest types of productiveness known are here given. Their comparison with analyses later presented may be of interest.

	Type 1 Heavy Clay soil (Buckshot soil) Yazoo Bottom land, Mississippi	*Type 2 Dark Loam Arroyo Grande Valley, Cal.*
Insoluble and soluble silica (SiO_2)	71.77%	72.43%
Potash (K_2O)	1.10	.67
Soda (Na_2O)	.33	.18
Lime (CaO)	1.35	2.11
Magnesia (MgO)	1.67	2.26
Iron (Fe_2O_3)	5.82	5.23
Alumina (Al_2O_3)	10.54	7.40
Phosphoric Acid (P_2O_5)	.30	.71
Water and organic matter	7.37	6.63
Nitrogen	–	.67

Compared with these are two virgin soils showing the lowest limits of plant foods consonant with good productiveness.

	Type 1 Clay	*Type 2 Sandy*
Potash (K_2O)	.15%	.05%
Soda (Na_2O)	.04	.06
Lime (CaO)	.12	.10
Magnesia (MgO)	.21	.12
Iron (Fe_2O_3)	1.18	.52
Alumina (Al_2O_3)	3.22	.46
Phosphoric acid (P_2O_5)	.08	.10
Organic matter	2.70	3.02

These soils are only good because of great depth, and probably also easy availability of the foods. Hilgard regards figures of 1% potash, 1% lime, 1% magnesia and .15% phosphoric acid as high for virgin soils. He also assumes that soils containing less than .25% potash will probably require early fertilization by potash salts, while .45% is adequate, and soils showing such a figure will require no fertilization. If lime is present in abundance lower percentages of potash, nitrogen and phosphoric acid are permissible.

From the great mass of analytical work done in connection with the Rothamsted Station and

elsewhere in England, certain conclusions have been drawn which may be summarized as follows:

1. Potash. For carbohydrate-producing soils, *i.e.*, for sugar and starch producing crops, an abundance of potash is required. The better the water supply the lower the percentage of potash needed. In some instances available potash in as small amounts as .02% to .04% is satisfactory. Obviously this does not apply to tropical soils with torrential rainfall and excessive leaching.

2. The nitrogen is generally about 3% of the loss on ignition. High nitrogen is not necessarily typical of good soils.

3. The iron content of light soils is 1–2.50%; of good loams and poor clays, 3.5–5%.

4. The ratio of lime to magnesia varies from 1:1 to 5:1.

5. The ratio of potash to clay is in general about 1 to 30.

6. The phosphoric acid varies with the type of soil: chalk soils generally show .20% to .25%; loams, .15% to .20%; sandy loams, about .10%; and clays and poor sands, less than .10%. The available phosphoric acid varies enormously.

Some interesting facts have been learned regarding the relative effects of potash, phosphoric acid and nitrogen, which although worked out for temperate zone conditions, with diversified crops, may be of equal importance in the tropics.

Potash

(1) is essential for starch formation.
(2) gives tone and vigor to plants.
(3) counteracts too much nitrogen.

(4) delays maturity.
(5) acts as a balance to nitrogen and phosphoric acid.
(6) may be present in large amounts and do no harm.
(7) promotes resistance to disease.

Phosphorus

(1) hastens maturity.
(2) increases root development.
(3) increases ratio of fruit to leaf.
(4) strengthens stem.
(5) improves quality of crop.
(6) increases resistance to disease.

Nitrogen

(1) tends to increase leafage, and
(2) delays maturity by increasing growing period.
(3) weakens stalks.
(4) lowers quality.
(5) increases nitrogen in crop.
(6) decreases resistance to disease.

This is a somewhat revolutionary view of the desirability of nitrogen, and does not seem applicable to tropical soils, which are all low.

In tropical soils the general analyses appear to be considerably lower than in those of temperate zones, so that different standards of judgment seem to be necessary because of the more intense decomposition, due to continuous heat and moisture and constant leaching. In the soils of Madagascar .10% potash seems to be high. In India similar figures are found. Hawaiian soils, on the other hand, show marked variations, as Burgess has shown, and as will appear on page 60.

Phosphoric acid rarely occurs in more than .30%

in non-ferrous soils, and nitrogen in amounts of .10% seems to be adequate.

On the basis of analyses in Madagascar, Maercker established the ratings of soils as given under the general discussion of lime as a plant food, and which may be repeated here, as the soils analyzed are, in this investigation, later to be subjected to this rating.

The analyses of Hawaiian soils by Burgess offer data of great interest, although probably not comparable with those of Central and South America. It must be borne in mind that the origin of the soils is entirely volcanic or basaltic, whereas our Central American soils are not pronouncedly of this character.

Burgess has tabulated the results of his analyses for phosphoric acid, potash, lime and nitrogen in a very interesting way, which is presented with some modification in form on the two following pages:

Plant Food Element	District No. 1		District No. 2		District No. 3		District No. 4	
	Upland	Lowland	Upland	Lowland	Upland	Lowland	Upland	Lowland
Total P_2O_5, %	.202	.304	.425	.680	.247	.340	.200	.377
Total P_2O_5, lbs. per acre foot	6,060	9,120	12,750	20,400	7,410	10,200	6,000	11,310
Available P_2O_5, %	.0156	.0247	.0062	.0095	.0134	.0129	.0076	.0158
Available P_2O_5, lbs. per acre foot	468	741	186	285	402	387	228	474
Total K_2O, %	.055	.055	.212	.263	.456	.407	.110	.233
Total K_2O, lbs. per acre foot	1,650	1,650	6,360	7,890	13,680	12,210	3,300	6,990
Available K_2O, %	.0181	.0126	.0220	.0352	.0250	.0376	.0605	.0554
Available K_2O, lbs. per acre foot	543	378	660	1,056	750	1,128	1,815	1,662
Total CaO, %	1.32	1.87	0.36	0.50	0.21	0.30	3.26	4.28
Total CaO, lbs. per acre foot	39,600	56,100	10,800	15,000	6,300	9,000	97,800	128,400
Available CaO, %	.245	.329	.098	.171	.128	.162	.616	.600
Available CaO, lbs. per acre foot	7,350	9,870	2,940	5,130	3,840	4,860	18,480	18,000
Total Nitrogen, %	.91	.93	.60	.55	.46	.33	.47	.33
Total Nitrogen, lbs. per acre foot	27,300	27,900	18,000	16,500	13,800	9,900	14,100	9,900
Available Nitrogen, %	.00078	.0022	.0014	.0016	.0031	.0023	.0008	.0030
Available Nitrogen, lbs. per acre foot	39	110	70	80	155	115	40	150

Averaging all the analyses for these districts we find the following as the average for Hawaii:

	Phosphoric acid		*Potash*		*Lime*		*Nitrogen*	
	Upland	*Lowland*	*Upland*	*Lowland*	*Upland*	*Lowland*	*Upland*	*Lowland*
Total %	.268	.425	.208	.239	1.29	1.74	0.61	0.54
Lbs. per acre foot	8,040	12,750	6,240	7,170	38,700	52,200	18,300	16,200
Available %	.0107	.0157	.0314	.0352	.272	.315	.0015	.0023
Available lbs. per acre foot	321	471	942	1,056	8,160	9,450	75	115
Factor of availability	.04	.037	.15	.15	.21	.18	.0025	.0043

Dyer thinks 300 pounds of potash should be available for grain crops per acre nine inches. This may be more than required by the banana.

Ratio of Total to Available Plant Food

This is extremely variable and no figures even approximating an exact ratio can be given.

Burgess, in the examination of Hawaiian soils, has made determinations in a considerable series of samples and I have computed the ratios from some of his figures:

K_2O Total	K_2O Available	Ratio	K_2O Total	K_2O Available	Ratio
.082	.024	.30	.412	.056	.14
.040	.008	.20	.334	.052	.16
.05	.0155	.30	.526	.065	.12
.04	.013	.30	.453	.015	.04
.065	.016	.23	.348	.058	.16
.116	.013	.11	.332	.049	.15
.095	.004	.04	.431	.037	.09
.110	.015	.14	.364	.029	.09
.090	.004	.04	.410	.058	.14
.120	.012	.10	.307	.067	.21
.110	.017	.15	.179	.006	.03
.120	.031	.25	.210	.075	.35
.184	.017	.09	.160	.095	.59
.170	.022	.13	.110	.060	.55
.208	.032	.16	.142	.032	.23
.150	.012	.08	.133	.033	.25

The average figure obtained is about .20, that is, about 20% of the total potash is "available" at any given time.

X. Results of Soil Examinations in the Different Divisions

In the following sections the soils of the different divisions are separately considered and comparisons are made between them. Averages for each district in the separate divisions are also given in the summaries following the description sheets. General conclusions also have been drawn as to the character of the whole division.

The general consideration of the results of the six divisions and of the analyses of tropical soils has led me to the view that certain standards can be tentatively adopted for tropical soils and that when compared in this way a somewhat clearer view of their character is obtained than from the actual percentage figures. Tropical soils undoubtedly differ from those of the temperate zones, and in general show lower percentages of organic matter and nitrogen. This is contrary to what might seem to be logical in view of the continuous growth of plant life in the tropics, but it is perhaps because of this constant drain on the soil and the lack of the annual influx of organic matter due to the death of the plants, such as takes place in the temperate zones, that the result observed is due.

Potash	over .30%	= high
	under .15	= low
Lime	over 2.00	= high
	under 1.00	= low
Organic matter	over 12.00	= high
	under 8.00	= low
Nitrogen	over .25	= high
	under .12	= low
Phosphoric acid	over .30	= high
	under .15	= low

Tables of this character are given for each division.

Good soils may show low analyses if the physical conditions are favorable, but I believe figures for an entirely satisfactory tropical soil may be expressed as follows:

Potash	0.30% (or above)
Organic matter	10.00 to 15.00%
Nitrogen	0.25 to 0.30
Phosphoric acid	0.20 to 0.30
Lime	1.50 to 2.00

On the basis of these figures I have prepared tables for each division, in which I have classified the various ingredients as "high," "medium" and

"low," and have tried to present for direct comparison the results of chemical examination with the agricultural history, the depth of the soil and the rate of spread of the disease where this has taken place.

COSTA RICA DIVISION

The soils of the Costa Rica Division are largely of basic lava origin except in the Santa Clara District. Most of them are of alluvial character, the alluvium having been brought down by the swiftly flowing rivers from the hilly or mountainous country. The great majority of the banana lands of Costa Rica lie in the rather flat river valleys along the coastal plain. In some instances the mountains are relatively near, as for example in the Estrella District. The areas taken for examination were selected by Mr. G. P. Chittenden, Division Manager, and represent upland conditions in the Santa Clara District, and alluvial conditions in most of the other districts. No virgin woodland samples have been taken, although some soils on farms which are still very young have been collected. The Costa Rica soils should in general be classified as humid since there is no prolonged and distinctly dry season in this Division. The so-called dry season, extending over a few weeks, occurs in some years, while in other years this is not the case. The rainfall is large, averaging about 180 inches a year. The rivers frequently overflow their banks and inundate the low lying territory so that in many of the valleys the land is to a greater or less degree subject to silt deposition, or in case of extreme flooding, to scouring action. In the former case the type of silt deposited may or may not be favorable for agriculture, while in the latter case the surface organic-containing soil is likely to be carried away.

The agricultural histories which are given with each sample concern in most instances only the single crop, bananas, although in a few cases other crops are mentioned. Since in this Division we have had for several years serious inroads from the infection of plants by the fusarium of Panama Disease, the later agricultural history is largely concerned with the occurrence and rate of spread of this disease. The reports of productivity during the past five years are a better index of the degree of infection than of the fertility of the soil. In the older farms the record of productivity serves far better as a means of classifying the soils as to their agricultural value. In all those cases where infections occur among plants it is extremely difficult to distinguish between the effects of the infection and the inherent weaknesses of the soil itself. Whereas one crop may be markedly affected by a particular type of microbe, certain other crops, not affected by this particular germ, might in many instances thrive exceedingly. This seems to be the case in a number of instances in the Costa Rica Division where plants not affected by the fungus in question have been grown. Another enemy, the taltusa, a burrowing rodent, has had some although much less effect on the agricultural history, as in a few farms the inroads of this animal have been sufficient to cause remark. On the following pages will be found the records of the observations on the soils of this Division. It will be noted that the Division is as a whole fairly high in iron and alumina, and this is particularly marked in the Santa Clara District, where an average of 10.83% is found for the iron content. As in general, the alumina is from two to three times as high as the iron. The Division is also characterized by low figures for lime and magnesia and in a few instances by low potash and nitrogen.

COSTA RICA DIVISION

SERIAL NUMBER *1*

Location: *Walkyria* Farm, Section ; *Below sawmill.* Date: *May, 1916.*

Other distinguishing features: *Left bank Guapiles River.* Collector: *L. W. W.*

NATURAL FEATURES

Topography: *Upland.*
Drainage: *Good.*
Flood conditions: *None.*
Silt deposition: *None.*
Type of forest growth: *Probably heavy.*

CULTIVATION HISTORY

When cleared and planted: *Summer 1910.*
Number of replantings: *None.* Why? *Taltusa and disease.*
General condition when in production: *Good for three years, falling off to bad.*
Plowed? *No.* When? Grubbed? *No.* When?
Years in bananas: *Five.* Life of farm: *Abandoned in 1915.*
Years in bush or fallow: *In bush since 1915.*
Other crops grown: *None.*

DISEASE HISTORY

When first noted: *1912.*
Age of plants when attacked: *About a year.*
Rapidity of spread: *Rapid.*
Treatment given: *None.*

OTHER DATA

	Surface—6″	6″—18″	18″—30″
Physical Examination			
Color	black	dark brown	dark brown
Compactness	loose	loose	loose
Friability	sandy	sandy	sandy
Retentive Power	66	52	42
Mechanical Examination			
Coarse gravel	0	0	0
Fine gravel	1.4	3.7	1.9
Coarse sand	6.7	8.1	7.5
Fine sand	44.9	38.0	42.2
Silt	41.1	45.2	44.2
Clay	5.9	5.0	4.2
Chemical Examination			
Organic matter	14,47	9.50	6.68
Total Nitrogen	.42	.24	.17
Potash (K_2O)	.19	.13	.17
Phosphoric acid (P_2O_5)	.35	.26	.29
Lime (CaO)	1.05	.87	.74
Magnesia (MgO)	.52	.77	.32
Iron (Fe_2O_3)	5.65	6.32	6.00
Alumina (Al_2O_3)	7.17	7.38	8.18
Silica, sol. (SiO_2)			
Free Acidity			
Mycological Examination			
Typical Fusaria	Soil heavily diseased		
Other Fusaria			

COSTA RICA DIVISION

SERIAL NUMBER *2*

Location: *Precipicio* Farm, Section .

Date: *May, 1916.*

Collector: *L. W. W.*

Other distinguishing features: *Behind Africa Village.*

NATURAL FEATURES

Topography: *Hilltop.*
Drainage: *Good, natural.*
Flood conditions: *None.*
Silt deposition: *None.*
Type of forest growth: *Probably heavy.*

CULTIVATION HISTORY

When cleared and planted: *From 1890 to date.*
Number of replantings: *Many.* Why? *In bananas on and off.*
General condition when in production: *Good for about one crop.*
Plowed? *Yes.* When? 1911. Grubbed? *Yes.* When? 1911.
Years in bananas: *15 or more.* Life of farm: *Last planting lasted two years.*
Years in bush or fallow: *Part of the time for 15 years.*
Other crops grown: *None.*

DISEASE HISTORY

When first noted: *In 1911.*
Age of plants when attacked: *When plants were six months old.*
Rapidity of spread: *Rapid.*
Treatment given: *Spreading lime on stumps and forking in.*

OTHER DATA

	Surface—6″	6″—18″	18″—30″
Physical Examination			
Color	dark brown	red brown	brown
Compactness	hard	hard	hard
Friability	refractory	refractory	refractory
Retentive Power	60	62	65
Mechanical Examination			
Coarse gravel	0	0	0
Fine gravel	2.7	2.6	0.5
Coarse sand	22.6	28.4	22.7
Fine sand	34.9	33.6	35.8
Silt	35.6	30.7	37.6
Clay	4.2	4.7	3.4
Chemical Examination			
Organic matter	15.65	17.41	16.47
Total Nitrogen	.27	.27	.16
Potash (K_2O)	.10	.09	.10
Phosphoric acid (P_2O_5)	.30	.32	.27
Lime (CaO)	0	0	0
Magnesia (MgO)	0	0	0
Iron (Fe_2O_3)	11.11	13.65	13.10
Alumina (Al_2O_3)	23.37	31.61	31.70
Silica, sol. (SiO_2)			
Free Acidity			
Mycological Examination			
Typical Fusaria	Soil heavily diseased		
Other Fusaria			

COSTA RICA DIVISION

SERIAL NUMBER *3*

Location: *Las Mercedes* Farm, Section . Date: *May, 1916.*

Other distinguishing features: *Behind Oklahoma house.* Collector: *L. W. W.*

NATURAL FEATURES

Topography: *Upland.*
Drainage: *Fair.*
Flood conditions: *None.*
Silt deposition: *None.*
Type of forest growth: *Probably heavy.*

CULTIVATION HISTORY

When cleared and planted: *About 1890.*
Number of replantings: *Seven or more.* Why? *Local practice.*
General condition when in production: *Good for several crops, tapering to bad.*
Plowed? *Yes.* When? *1911 and 1912.* Grubbed? *Yes.* When? *1911.*
Years in bananas: *15 or more.* Life of farm: *Production has been good but now falling off.*
Years in bush or fallow: *About 10 from 1901 on.*
Other crops grown: *None.*

DISEASE HISTORY

When first noted: *1911.*
Age of plants when attacked: *About a year old.*
Rapidity of spread: *Slow.*
Treatment given: *In 1911–12 spots were limed, since 1912 no treatment.*

OTHER DATA

	Surface—6″	6″—18″	18″—30″
Physical Examination			
Color	brown	black	black
Compactness	firm	firm	firm
Friability	heavy	heavy	heavy
Retentive power	75	80	66
Mechanical Examination			
Coarse gravel	few rocks	0	few rocks
Fine gravel	27.7	33.9	42.4
Coarse sand	16.7	18.3	17.8
Fine sand	26.0	26.9	19.8
Silt	22.2	14.1	13.7
Clay	7.4	6.8	6.3
Chemical Examination			
Organic matter	20.29	14.92	17.08
Total Nitrogen	.59	.41	.02
Potash (K_2O)	.32	.25	.34
Phosphoric acid (P_2O_5)	.72	.56	.93
Lime (CaO)	1.05	.56	.34
Magnesia (MgO)	.33	.55	.25
Iron (Fe_2O_3)	4.33	8.63	8.35
Alumina (Al_2O_3)	17.35	16.48	17.10
Silica, sol. (SiO_2)			
Free Acidity			
Mycological Examination			
Typical Fusaria	Soil is diseased		
Other Fusaria			

COSTA RICA DIVISION

Serial Number 4

Location: *America* Farm, Section ; *Lime Patch.* Date: *May, 1916.*

Other distinguishing features: Collector: *L. W. W.*

Natural Features

Topography: *Upland.*
Drainage: *Fair.*
Flood conditions: *None.*
Silt deposition: *None.*
Type of forest growth: *Probably heavy.*

Cultivation History

When cleared and planted: *1902.*
Number of replantings: *About seven.* Why? *Local practice.*
General condition when in production: *Good for few years, tapering off.*
Plowed? *Yes.* When? *1912.* Grubbed? *No.* When?
Years in bananas: *About 12.* Life of farm: *Now abandoned for bananas.*
Years in bush or fallow:
Other crops grown: *Now in lime trees which are two years old.*

Disease History

When first noted: *1906.*
Age of plants when attacked: *4 years.*
Rapidity of spread: *Fairly rapid.*
Treatment given: *After plowing of 1912, liming was used.*

Other Data

	Surface—6″	6″—18″	18″—30″
Physical Examination			
Color	dark brown	dark brown	brown
Compactness	firm	firm	firm
Friability	heavy	heavy	heavy
Retentive Power	62	69	57
Mechanical Examination			
Coarse gravel	0	0	0
Fine gravel	50.5	51.5	53.9
Coarse sand	14.1	18.6	13.5
Fine sand	18.0	17.9	16.0
Silt	10.6	5.8	10.3
Clay	6.8	6.2	6.3
Chemical Examination			
Organic matter	23.35	22.75	19.82
Total Nitrogen	.43	.09	.01
Potash (K_2O)	.16	.15	.15
Phosphoric acid (P_2O_5)	.28	.31	.35
Lime (CaO)	.26	0	0
Magnesia (MgO)	.13	0	0
Iron (Fe_2O_3)	14.93	15.02	15.49
Alumina (Al_2O_3)	31.70	33.80	33.02
Silica, sol. (SiO_2)			
Free Acidity			
Mycological Examination			
Typical Fusaria	Soil is diseased		
Other Fusaria			

COSTA RICA DIVISION

SERIAL NUMBER 5

Location: *Louisiana* Farm, Section ; *Right side junction A line and Cairo branch.*

Date: *May, 1916.*
Collector: *L. W. W.*

Other distinguishing features:

NATURAL FEATURES

Topography: *Hillside.*
Drainage: *Good.*
Flood conditions: *None.*
Silt deposition: *None.*
Type of forest growth: *Probably heavy.*

CULTIVATION HISTORY

When cleared and planted: *About 1898.*
Number of replantings: *About seven.* Why? *By supplying.*
General condition when in production: *Good for four years, then falling off.*
Plowed? *Yes.* When? *1910.* Grubbed? *Yes.* When? *1910.*
Years in bananas: *About 15.* Life of farm: *Abandoned in 1913.*
Years in bush or fallow: *Never.*
Other crops grown: *Congos planted in 1913, and still there.*

DISEASE HISTORY

When first noted: *1909.*
Age of plants when attacked: *After 11 years in bananas.*
Rapidity of spread: *After replanting in 1910, disease soon appeared and spread rapidly.*
Treatment given: *None.*

OTHER DATA

	Surface—6″	6″—18″	18″—30″
Physical Examination			
Color	brown	brown	brown
Compactness	hard	hard	hard
Friability	heavy	heavy	heavy
Retentive Power	58	62	59
Mechanical Examination			
Coarse gravel	few stones	0	few stones
Fine gravel	22.8	19.5	36.4
Coarse sand	18.5	24.0	14.5
Fine sand	24.5	29.2	23.6
Silt	29.7	21.6	18.5
Clay	4.5	5.7	7.0
Chemical Examination			
Organic matter	22.75	19.72	18.02
Total Nitrogen	.27	.15	.03
Potash (K_2O)	.15	.17	.27
Phosphoric acid (P_2O_5)	.28	.44	.45
Lime (CaO)	.25	.16	.13
Magnesia (MgO)	.46	.46	.27
Iron (Fe_2O_3)	16.60	15.85	7.28
Alumina (Al_2O_3)	31.98	33.02	8.18
Silica, sol. (SiO_2)			
Free Acidity			
Mycological Examination			
Typical Fusaria	Soil is diseased		
Other Fusaria			

COSTA RICA DIVISION

Serial Number *6*

Location: *La Amelia* Farm, Section ; *100 meters back of platform along tram.* Date: *May, 1916.*

Other distinguishing features: Collector: *L. W. W.*

Natural Features

Topography: *Bottom land.*
Drainage: *Good.*
Flood conditions: *Three or four times a year.*
Silt deposition: *Six to eight inches.*
Type of forest growth: *Probably heavy.*

Cultivation History

When cleared and planted: *1905.*
Number of replantings: *None.* Why? *Except by supplying.*
General condition when in production: *Excellent to the present time.*
Plowed? *No.* When? Grubbed? *No.* When?
Years in bananas: *Eleven.* Life of farm: *Still good producer.*
Years in bush or fallow: *Never.*
Other crops grown: *None.*

Disease History

When first noted: *1913.*
Age of plants when attacked: *Eight years.*
Rapidity of spread: *Medium.*
Treatment given: *None.*

Other Data

	Surface—6″	6″—18″	18″—30″
Physical Examination			
Color	light brown	light brown	light brown
Compactness	fine	fine	fine
Friability	light	light	light
Retentive Power	86	80	68
Mechanical Examination			
Coarse gravel	0	0	0
Fine gravel	0	0.5	0
Coarse sand	29.1	26.8	28.4
Fine sand	23.0	27.5	27.1
Silt	41.6	38.6	38.0
Clay	6.3	6.6	6.5
Chemical Examination			
Organic matter	12.88	8.97	8.84
Total Nitrogen	.32	.19	.18
Potash (K_2O)	.36	.54	.39
Phosphoric acid (P_2O_5)	.35	.32	.34
Lime (CaO)	1.45	1.56	1.59
Magnesia (MgO)	.34	.54	.56
Iron (Fe_2O_3)	7.32	8.16	8.33
Alumina (Al_2O_3)	14.00	13.72	13.29
Silica, sol. (SiO_2)			
Free Acidity			
Mycological Examination			
Typical Fusaria	Soil is diseased		
Other Fusaria			

COSTA RICA DIVISION

SERIAL NUMBER 7

Location: *Carmen* Farm, Section .

Date: *May, 1916.*

Other distinguishing features: *At Bridgefoot.*

Collector: *L. W. W.*

NATURAL FEATURES

Topography: *Bottom land.*
Drainage: *Good.*
Flood conditions: *Three or four times a year.*
Silt deposition: *Six to eighteen inches.*
Type of forest growth: *Probably heavy.*

CULTIVATION HISTORY

When cleared and planted: *1907 but killed out by sand in 1908.*
Number of replantings: *One in 1910.* Why? *See above.*
General condition when in production: *Good.*
Plowed? *Yes.* When? *1910.* Grubbed? *No.* When?
Years in bananas: *Five.* Life of farm: *Still good.*
Years in bush or fallow: *Between 1908 and 1910.*
Other crops grown: *None.*

DISEASE HISTORY

When first noted: *1914.*
Age of plants when attacked: *Four years.*
Rapidity of spread: *Medium.*
Treatment given: *None.*

OTHER DATA

After plowing in 1911 was heavily mulched with grass and cacao trash.

	Surface—6"	6"—18"	18"—30"
Physical Examination			
Color	light brown	light brown	light brown
Compactness	fine	fine	fine
Friability	light	light	light
Retentive Power	81	72	85
Mechanical Examination			
Coarse gravel	0	0	0
Fine gravel	0	0	0
Coarse sand	9.1	9.6	13.6
Fine sand	14.9	13.6	22.5
Silt	70.7	72.2	57.9
Clay	5.3	4.6	6.0
Chemical Examination			
Organic matter	9.07	7.42	11.05
Total Nitrogen	.18	.10	.20
Potash (K_2O)	.24	.41	.35
Phosphoric acid (P_2O_5)	.21	.35	.37
Lime (CaO)	1.28	2.66	2.84
Magnesia (MgO)	.46	1.37	.68
Iron (Fe_2O_3)	5.08	6.77	7.17
Alumina (Al_2O_3)	8.13	9.85	11.41
Silica, sol. (SiO_2)			
Free Acidity			
Mycological Examination			
Typical Fusaria	Soil is diseased		
Other Fusaria			

COSTA RICA DIVISION

SERIAL NUMBER *8*

Location: *La Lola* Farm, Section ; *100 meters back of platform.* Date: *May, 1916.*

Other distinguishing features: Collector: *L. W. W.*

NATURAL FEATURES

Topography: *Upland.*
Drainage: *Fair.*
Flood conditions: *None.*
Silt deposition: *None.*
Type of forest growth: *Probably heavy.*

CULTIVATION HISTORY

When cleared and planted: *1890.*
Number of replantings: *About seven.* Why? *By supplying.*
General condition when in production: *Good to poor.*
Plowed? *Yes.* When? *1910.* Grubbed? *Yes.* When? *1910.*
Years in bananas: *Twenty-six.* Life of farm: *Banana production about over.*
Years in bush or fallow: *Six years in pasture.*
Other crops grown: *Cacao planted 1915.*

DISEASE HISTORY

When first noted: *About 1906.*
Age of plants when attacked: *About four years old.*
Rapidity of spread: *Rapid.*
Treatment given: *Digging out and liming.*

OTHER DATA

	Surface—6"	6"—18"	18"—30"
Physical Examination			
Color	light brown	light brown	light brown
Compactness	loose	loose	loose
Friability	light	light	light
Retentive Power	78	68	60
Mechanical Examination			
Coarse gravel	0	0	0
Fine gravel	0.8	5.2	0.3
Coarse sand	22.9	25.1	12.2
Fine sand	37.5	39.5	29.5
Silt	33.3	25.0	52.1
Clay	5.5	5.2	5.9
Chemical Examination			
Organic matter	12.40	10.00	8.22
Total Nitrogen	.28	.17	.09
Potash (K_2O)	.20	.15	.24
Phosphoric acid (P_2O_5)	.25	.21	.21
Lime (CaO)	1.66	2.12	1.48
Magnesia (MgO)	1.14	1.24	1.11
Iron (Fe_2O_3)	9.95	10.83	10.60
Alumina (Al_2O_3)	12.97	12.81	16.08
Silica, sol. (SiO_2)			
Free Acidity			
Mycological Examination			
Typical Fusaria	Soil is diseased		
Other Fusaria			

COSTA RICA DIVISION

SERIAL NUMBER 9

Location: *Baltimore* Farm, Section ; *Junction of Baltimore and Esperanza main lines.*

Date: *May, 1916.*
Collector: *L. W. W.*

Other distinguishing features:

NATURAL FEATURES

Topography: *Valley.*
Drainage: *Fair.*
Flood conditions: *None.*
Silt deposition: *None.*
Type of forest growth: *Probably heavy.*

CULTIVATION HISTORY

When cleared and planted: *1905.*
Number of replantings: *About four.* Why? *By supplying.*
General condition when in production: *Good for one year, after that very bad.*
Plowed? *Yes.* When? *1910.* Grubbed? *No.* When?
Years in bananas: *Four.* Life of farm: *Abandoned for bananas 1911.*
Years in bush or fallow: *Two, 1911–12.*
Other crops grown: *Congos in 1913, and Cacao in 1915.*

DISEASE HISTORY

When first noted: *1906.*
Age of plants when attacked: *Nine months to a year old.*
Rapidity of spread: *Rapid.*
Treatment given: *Congos introduced.*

OTHER DATA

	Surface—6"	6"—18"	18"—30"
Physical Examination			
Color	light brown	light brown	light brown
Compactness	loose	loose	loose
Friability	light	light	light
Retentive Power	76	52	43
Mechanical Examination			
Coarse gravel	0	0	0
Fine gravel	6.4	9.2	7.4
Coarse sand	9.2	9.9	8.5
Fine sand	24.6	20.3	16.8
Silt	54.7	56.1	62.6
Clay	5.1	4.5	4.7
Chemical Examination			
Organic matter	14.35	8.52	6.29
Total Nitrogen	.40	.15	.08
Potash (K_2O)	.22	.31	.32
Phosphoric acid (P_2O_5)	.07	.14	.20
Lime (CaO)	1.93	1.96	1.42
Magnesia (MgO)	1.34	2.10	2.22
Iron (Fe_2O_3)	8.30	7.81	9.11
Alumina (Al_2O_3)	10.72	8.24	10.86
Silica, sol. (SiO_2)			
Free Acidity			
Mycological Examination			
Typical Fusaria	Soil is diseased		
Other Fusaria			

COSTA RICA DIVISION

SERIAL NUMBER *10*

Location: *Bristol* Farm, Section *; Junction of Baltimore and A line.* Date: *May, 1916.*

Other distinguishing features: Collector: *L. W. W.*

NATURAL FEATURES

Topography: *Bottom land.*
Drainage: *Good.*
Flood conditions: *None.*
Silt deposition: *None.*
Type of forest growth: *Probably heavy.*

CULTIVATION HISTORY

When cleared and planted: *By squatters in 1900, by U. F. Co. in 1906.*
Number of replantings: *Two, 1906 and 1910.* Why? *Poor production.*
General condition when in production: *Good to bad.*
Plowed? *Yes.* When? *1910.* Grubbed? *Yes.* When? *1910.*
Years in bananas: *Thirteen.* Life of farm: *Abandoned 1913.*
Years in bush or fallow: *Since 1913.*
Other crops grown: *None.*

DISEASE HISTORY

When first noted: *1907 in squatter plantings.*
Age of plants when attacked: *About seven years.*
Rapidity of spread: *Prior to plowing and replanting slow, later rapid.*
Treatment given: *None.*

OTHER DATA

	Surface—6"	6"—18"	18"—30"
Physical Examination			
Color	dark brown	light brown	light brown
Compactness	loose	loose	loose
Friability	light	light	light
Retentive Power	78	60	57
Mechanical Examination			
Coarse gravel	0	0	0
Fine gravel	10.6	13.7	12.9
Coarse sand	16.5	13.6	10.0
Fine sand	22.8	22.3	20.5
Silt	43.7	46.7	52.3
Clay	6.4	3.7	4.3
Chemical Examination			
Organic matter	18.15	9.76	8.83
Total Nitrogen	.49	.19	.11
Potash (K_2O)	.22	.28	.36
Phosphoric acid (P_2O_5)	.28	.34	.23
Lime (CaO)	1.94	1.75	1.51
Magnesia (MgO)	.57	1.95	1.61
Iron (Fe_2O_3)	9.17	8.62	8.07
Alumina (Al_2O_3)	9.45	10.61	11.40
Silica, sol. (SiO_2)			
Free Acidity			
Mycological Examination			
Typical Fusaria	Soil is diseased		
Other Fusaria			

COSTA RICA DIVISION

SERIAL NUMBER *11*

Location: *Luisa East* Farm, Section *; Junction of main and A line.* Date: *May, 1916.*

Other distinguishing features: Collector: *L. W. W.*

NATURAL FEATURES

Topography: *Bottom land.*
Drainage: *Good.*
Flood conditions: *Two or three times a year.*
Silt deposition: *Four to six inches a year.*
Type of forest growth: *Probably heavy.*

CULTIVATION HISTORY

When cleared and planted: *1906.*
Number of replantings: *Three.* Why? *By supplying.*
General condition when in production: *For seven years excellent, later bad.*
Plowed? *No.* When? Grubbed? *No.* When?
Years in bananas: *Seven.* Life of farm: *Production now poor.*
Years in bush or fallow: *Never.*
Other crops grown: *None.*

DISEASE HISTORY

When first noted: *1907.*
Age of plants when attacked: *About a year old.*
Rapidity of spread: *Medium.*
Treatment given: *In 1911–12 digging out and liming.*

OTHER DATA

	Surface—6"	6"—18"	18"—30"
PHYSICAL EXAMINATION			
Color	light brown	light brown	light brown
Compactness	loose	loose	loose
Friability	light	light	light
Retentive Power	93	69	69
MECHANICAL EXAMINATION			
Coarse gravel	0	0	0
Fine gravel	48.5	49.1	11.1
Coarse sand	16.5	13.0	17.5
Fine sand	17.2	15.5	34.6
Silt	10.0	14.9	30.2
Clay	7.8	7.5	6.6
CHEMICAL EXAMINATION			
Organic matter	14.90	11.67	9.50
Total Nitrogen	.40	.19	.13
Potash (K_2O)	.40	.38	.42
Phosphoric acid (P_2O_5)	.24	.21	.14
Lime (CaO)	2.27	2.06	1.86
Magnesia (MgO)	1.11	.98	3.00
Iron (Fe_2O_3)	7.70	9.03	9.99
Alumina (Al_2O_3)	10.87	13.70	10.31
Silica, sol. (SiO_2)			
Free Acidity			
MYCOLOGICAL EXAMINATION			
Typical Fusaria	Soil is diseased		
Other Fusaria			

COSTA RICA DIVISION

SERIAL NUMBER *12*

Location: *Philadelphia North* Farm, Section *; West of foreman's house.*

Date: *May, 1916.*
Collector: *L. W. W.*

Other distinguishing features:

NATURAL FEATURES

Topography: *Bottom land.*
Drainage: *Fair to poor.*
Flood conditions: *Every three or four years.*
Silt deposition: *Light.*
Type of forest growth: *Probably heavy.*

CULTIVATION HISTORY

When cleared and planted: *1903–4.*
Number of replantings: *10% each year.* Why? *For about six years.*
General condition when in production: *Good for two years, later fair.*
Plowed? *Yes.* When? *1910.* Grubbed? *Yes.* When? *1910.*
Years in bananas: *Ten.* Life of farm: *Abandoned 1913.*
Years in bush or fallow: *Two.*
Other crops grown: *Cacao planted 1915.*

DISEASE HISTORY

When first noted: *1906.*
Age of plants when attacked: *Two years old.*
Rapidity of spread: *Medium until plowed, then very fast.*
Treatment given: *Digging out and liming.*

OTHER DATA

	Surface—6"	6"—18"	18"—30"
Physical Examination			
Color	light brown	yellow brown	yellow brown
Compactness	very hard	very hard	very hard
Friability	heavy	heavy	heavy
Retentive Power	70	55	55
Mechanical Examination			
Coarse gravel	0	0	0
Fine gravel	0	0	0
Coarse sand	15.9	6.4	12.3
Fine sand	26.9	17.4	17.7
Silt	54.1	71.9	65.3
Clay	3.1	4.3	4.7
Chemical Examination			
Organic matter	11.80	6.42	7.46
Total Nitrogen	.18	.13	.08
Potash (K_2O)	.45	.37	.35
Phosphoric acid (P_2O_5)	.17	.15	.14
Lime (CaO)	1.55	1.84	2.04
Magnesia (MgO)	.64	1.07	.82
Iron (Fe_2O_3)	8.25	8.14	8.95
Alumina (Al_2O_3)	9.03	11.88	10.62
Silica, sol. (SiO_2)			
Free Acidity			
Mycological Examination			
Typical Fusaria	Soil is diseased		
Other Fusaria			

COSTA RICA DIVISION

SERIAL NUMBER *13*

Location: *Bananito South* Farm, Section ; *100 meters back of platform.* Date: *May, 1916.*
Other distinguishing features: Collector: *L. W. W.*

NATURAL FEATURES

Topography: *Bottom land.*
Drainage: *Good.*
Flood conditions: *About three times a year.*
Silt deposition: *Heavy.*
Type of forest growth: *Probably heavy.*

CULTIVATION HISTORY

When cleared and planted: *1909.*
Number of replantings: *About 10%.* Why? *By supplying.*
General condition when in production: *Good.*
Plowed? *No.* When? Grubbed? *No.* When?
Years in bananas: *Seven.* Life of farm: *Still good.*
Years in bush or fallow: *Never.*
Other crops grown: *None.*

DISEASE HISTORY

When first noted: *1913.*
Age of plants when attacked: *Four years old.*
Rapidity of spread: *Slow.*
Treatment given: *None.*

OTHER DATA

	Surface—6"	6"—18"	18"—30"
Physical Examination			
Color	light brown	light brown	light brown
Compactness	very fine	very fine	very fine
Friability	light	light	light
Retentive Power	63	73	59
Mechanical Examination			
Coarse gravel	0	0	0
Fine gravel	0	0	0
Coarse sand	15.6	8.8	6.4
Fine sand	20.4	25.9	19.3
Silt	59.8	59.7	69.8
Clay	4.2	5.6	4.5
Chemical Examination			
Organic matter	7.33	8.63	8.87
Total Nitrogen	.23	.17	.08
Potash (K_2O)	.38	.28	.30
Phosphoric acid (P_2O_5)	.18	.18	.17
Lime (CaO)	2.05	1.55	1.40
Magnesia (MgO)	.78	.69	.76
Iron (Fe_2O_3)	8.12	8.15	8.87
Alumina (Al_2O_3)	7.52	9.82	9.72
Silica, sol. (SiO_2)			
Free Acidity			
Mycological Examination			
Typical Fusaria	Soil is diseased		
Other Fusaria			

COSTA RICA DIVISION

SERIAL NUMBER *14*

Location: *San Clemente* Farm, Section ; *Mile 25* Date: *May, 1916.*

Other distinguishing features: *Where mulching has been done.* Collector: *L. W. W.*

NATURAL FEATURES

Topography: *Bottom land.*
Drainage: *Medium.*
Flood conditions: *Once a year.*
Silt deposition: *Very little.*
Type of forest growth: *Heavy.*

CULTIVATION HISTORY

When cleared and planted: *1913.*
Number of replantings: *None.* Why?
General condition when in production: *Poor to excellent after mulching.*
Plowed? *No.* When? Grubbed? *No.* When?
Years in bananas: *Three.* Life of farm: *Good producer.*
Years in bush or fallow: *Never.*
Other crops grown: *None.*

DISEASE HISTORY

When first noted: *1915.*
Age of plants when attacked: *Two years.*
Rapidity of spread: *Slow.*
Treatment given: *None.*

OTHER DATA

After bananas had been planted one year, appearance and condition of growth were bad. Area was heavily mulched with banana trash and improvement in condition was almost immediate. Now compares favorably in color and amount of fruit produced with any section in farm.

	Surface—6″	6″—18″	18″—30″
Physical Examination			
Color	dark brown	dark brown	dark brown
Compactness	hard	hard	hard
Friability	heavy	heavy	heavy
Retentive Power	87	70	72
Mechanical Examination			
Coarse gravel	0	0	0
Fine gravel	0	0	1.8
Coarse sand	17.8	27.8	20.5
Fine sand	32.0	28.1	31.3
Silt	44.3	38.9	41.0
Clay	5.9	5.2	5.4
Chemical Examination			
Organic matter	15.18	11.10	6.86
Total Nitrogen	.48	.21	.09
Potash (K_2O)	.47	.26	.47
Phosphoric acid (P_2O_5)	.29	.18	.15
Lime (CaO)	1.49	.77	1.41
Magnesia (MgO)	.59	.66	.35
Iron (Fe_2O_3)	8.92	9.08	11.33
Alumina (Al_2O_3)	9.26	12.40	10.88
Silica, sol. (SiO_2)			
Free Acidity			
Mycological Examination			
Typical Fusaria	Soil is diseased		
Other Fusaria			

COSTA RICA DIVISION

SERIAL NUMBER *15*

Location: *Pandora* Farm, Section ; *Mile 32.* Date: *May, 1916.*

Other distinguishing features: Collector: *L. W. W.*

NATURAL FEATURES

Topography: *Bottom land.*
Drainage: *Good.*
Flood conditions: *Once a year.*
Silt deposition: *Light.*
Type of forest growth: *Heavy.*

CULTIVATION HISTORY

When cleared and planted: *1913 but destroyed by flood and replanted 1914.*
Number of replantings: *One.* Why? *See above.*
General condition when in production: *Good.*
Plowed? *No.* When? Grubbed? *No.* When?
Years in bananas: *Two.* Life of farm: *Good producer.*
Years in bush or fallow: *Never.*
Other crops grown: *None.*

DISEASE HISTORY

When first noted: *Early in 1916.*
Age of plants when attacked: *18 months.*
Rapidity of spread: *Slow.*
Treatment given: *Digging out and bleaching.*

OTHER DATA

	Surface—6"	6"—18"	18"—30"
Physical Examination			
Color	light brown	light brown	light brown
Compactness	hard	hard	hard
Friability	heavy	heavy	heavy
Retentive Power	81	69	66
Mechanical Examination			
Coarse gravel	0	0	0
Fine gravel	11.5	17.0	22.6
Coarse sand	28.9	17.5	16.4
Fine sand	24.8	21.7	19.2
Silt	27.8	37.1	35.6
Clay	7.0	6.7	6.2
Chemical Examination			
Organic matter	12.32	11.30	9.57
Total Nitrogen	.42	.34	.18
Potash (K_2O)	.54	.57	.19
Phosphoric acid (P_2O_5)	.20	.21	.21
Lime (CaO)	1.29	1.02	1.40
Magnesia (MgO)	.74	.64	1.50
Iron (Fe_2O_3)	7.95	6.94	9.15
Alumina (Al_2O_3)	12.79	11.16	17.98
Silica, sol. (SiO_2)			
Free Acidity			
Mycological Examination			
Typical Fusaria	Soil is diseased		
Other Fusaria			

COSTA RICA DIVISION

SERIAL NUMBER *16*

Location: *Fortuna* Farm, Section ; *Mile 34.*

Date: *May, 1916.*

Collector: *L. W. W.*

Other distinguishing features:

NATURAL FEATURES

Topography: *Bottom land.*
Drainage: *Good.*
Flood conditions: *Two or three times yearly.*
Silt deposition: *Heavy.*
Type of forest growth: *Heavy.*

CULTIVATION HISTORY

When cleared and planted: *1913.*
Number of replantings: *None.* Why?
General condition when in production: *Good.*
Plowed? *No.* When? Grubbed? *No.* When?
Years in bananas? *Three.* Life of farm: *Excellent producer.*
Years in bush or fallow: *Never.*
Other crops grown: *None.*

DISEASE HISTORY

When first noted: *1914.*
Age of plants when attacked: *About a year.*
Rapidity of spread: *Slow.*
Treatment given: *Digging out and bleaching.*

OTHER DATA

	Surface—6"	6"—18"	18"—30"
Physical Examination			
Color	light brown	light brown	light brown
Compactness	loose	loose	loose
Friability	light	light	light
Retentive Power	77	72	58
Mechanical Examination			
Coarse gravel	0	0	0
Fine gravel	12.9	7.2	10.8
Coarse sand	18.2	19.9	14.3
Fine sand	23.1	25.8	22.7
Silt	37.9	40.8	45.6
Clay	7.9	6.3	6.6
Chemical Examination			
Organic matter	13.95	9.17	9.90
Total Nitrogen	.33	.16	.10
Potash (K_2O)	.55	.50	.59
Phosphoric acid (P_2O_5)	.25	.23	.25
Lime (CaO)	2.44	2.24	2.45
Magnesia (MgO)	2.50	2.31	1.88
Iron (Fe_2O_3)	8.86	8.40	8.09
Alumina (Al_2O_3)	9.47	10.63	13.23
Silica, sol. (SiO_2)			
Free Acidity			
Mycological Examination			
Typical Fusaria	Soil is diseased		
Other Fusaria			

COSTA RICA DIVISION

SERIAL NUMBER *17*

Location: *Aurora* Farm, Section ; *Mile 35.*

Date: *May, 1916.*

Collector: *L. W. W.*

Other distinguishing features:

NATURAL FEATURES

Topography: *Bottom land.*
Drainage: *Good.*
Flood conditions: *Two or three times a year.*
Silt deposition: *Heavy.*
Type of forest growth: *Heavy.*

CULTIVATION HISTORY

When cleared and planted: *1913.*
Number of replantings: *None.* Why?
General condition when in production: *Good.*
Plowed? *No.* When? Grubbed? *No.* When?
Years in bananas: *Three.* Life of farm: *Production good.*
Years in bush or fallow: *Never.*
Other crops grown: *None.*

DISEASE HISTORY

When first noted: *1914.*
Age of plants when attacked: *About a year.*
Rapidity of spread: *Rapid.*
Treatment given: *Digging out and bleaching.*

OTHER DATA

	Surface—6"	6"—18"	18"—30"
Physical Examination			
Color	dark brown	light brown	light brown
Compactness	loose	loose	loose
Friability	light	light	light
Retentive Power		Average for all, 53	
Mechanical Examination			
Coarse gravel	0	0	0
Fine gravel	6.9	12.0	7.7
Coarse sand	8.3	12.6	7.8
Fine sand	22.4	22.8	32.3
Silt	57.5	47.9	48.5
Clay	4.9	4.7	3.7
Chemical Examination			
Organic matter	11.70	9.29	5.87
Total Nitrogen	.26	.12	.06
Potash (K_2O)	.58	.40	.93
Phosphoric acid (P_2O_5)	.22	.25	.18
Lime (CaO)	2.34	2.17	1.90
Magnesia (MgO)	1.51	1.78	1.88
Iron (Fe_2O_3)	8.10	7.46	6.95
Alumina (Al_2O_3)	11.47	11.18	7.52
Silica, sol. (SiO_2)			
Free Acidity			
Mycological Examination			
Typical Fusaria	Soil is diseased		
Other Fusaria			

COSTA RICA DIVISION

SERIAL NUMBER *18*

Location: *Talia* Farm, Section *37*.

Date: *May, 1916.*

Collector: *L. W. W.*

Other distinguishing features: *Pasture.*

NATURAL FEATURES

Topography: *Hilltop.*
Drainage: *Fair.*
Flood conditions: *Occasionally.*
Silt deposition: *Occasionally.*
Type of forest growth: *Heavy.*

CULTIVATION HISTORY

When cleared and planted: *1914 but after floods of 1914 was turned into pasture.*
Number of replantings: Why?
General condition when in production:
Plowed? When? Grubbed? When?
Years in bananas: Life of farm:
Years in bush or fallow:
Other crops grown:

DISEASE HISTORY

When first noted:
Age of plants when attacked:
Rapidity of spread:
Treatment given:

OTHER DATA

No disease while in bananas.

	Surface—6″	6″—18″	18″—30″
Physical Examination			
Color	light brown	light brown	light brown
Compactness	loose	loose	loose
Friability	light	light	light
Retentive Power	77	69	64
Mechanical Examination			
Coarse gravel	0	0	0
Fine gravel	10.0	3.6	8.8
Coarse sand	23.7	28.7	23.8
Fine sand	27.4	27.7	28.8
Silt	38.0	32.4	30.0
Clay	.9	7.6	8.6
Chemical Examination			
Organic matter	14.70	11.52	10.52
Total Nitrogen	.37	.23	.14
Potash (K_2O)	.36	.33	.53
Phosphoric acid (P_2O_5)	.25	.25	.25
Lime (CaO)	2.01	2.82	1.95
Magnesia (MgO)	1.60	2.12	1.86
Iron (Fe_2O_3)	7.88	7.66	8.30
Alumina (Al_2O_3)	11.48	13.76	12.91
Silica, sol. (SiO_2)			
Free Acidity			
Mycological Examination			
Typical Fusaria	Soil samples in 1915 were positive		
Other Fusaria			

COSTA RICA DIVISION

SERIAL NUMBER *19*

Location: *Indiana I* Farm, Section .

Date: *May, 1916.*

Other distinguishing features: *By railroad.*

Collector: *L. W. W.*

NATURAL FEATURES

Topography: *Bottom land.*
Drainage: *Fair.*
Flood conditions: *None.*
Silt deposition: *None.*
Type of forest growth: *Heavy.*

CULTIVATION HISTORY

When cleared and planted: *1890.*
Number of replantings: *Once.* Why? *By supplying.*
General condition when in production: *Excellent until 1913, later bad.*
Plowed? *No.* When? Grubbed? *No.* When?
Years in bananas: *Twenty-three.* Life of farm: *Abandoned in 1913.*
Years in bush or fallow: *Since 1913.*
Other crops grown: *None.*

DISEASE HISTORY

When first noted: *1909.*
Age of plants when attacked: *Four years.*
Rapidity of spread: *Slow to rapid.*
Treatment given: *1912–13, liming.*

OTHER DATA

Soil is considered exhausted.

	Surface—6"	6"—18"	18"—30"
Physical Examination			
Color	dark brown	dark brown	dark brown
Compactness	loose	loose	loose
Friability	light	light	light
Retentive Power	78	52	39
Mechanical Examination			
Coarse gravel	0	0	0
Fine gravel	0	0	0
Coarse sand	11.4	7.8	2.5
Fine sand	31.8	29.1	31.7
Silt	55.6	58.1	60.5
Clay	1.2	5.0	5.3
Chemical Examination			
Organic matter	14.05	8.40	7.55
Total Nitrogen	.04	.09	.04
Potash (K_2O)	.25	.03	.02
Phosphoric acid (P_2O_5)	.25	.02	.05
Lime (CaO)	1.38	1.33	1.32
Magnesia (MgO)	.43	.61	.67
Iron (Fe_2O_3)	9.92	9.50	10.02
Alumina (Al_2O_3)			
Silica, sol. (SiO_2)			
Free Acidity			
Mycological Examination			
Typical Fusaria	Soil is diseased		
Other Fusaria			

COSTA RICA DIVISION

SERIAL NUMBER *20*

Location: *Indiana III* Farm, Section *8c.* Date: *May, 1916.*

Other distinguishing features: *By Pacuare River.* Collector: *L. W. W.*

NATURAL FEATURES

Topography: *Bottom land.*
Drainage: *Good.*
Flood conditions: *Five or six times a year.*
Silt deposition: *Heavy.*
Type of forest growth: *Heavy.*

CULTIVATION HISTORY

When cleared and planted: *1904–5.*
Number of replantings: *None.* Why?
General condition when in production: *Good.*
Plowed? *No.* When? Grubbed? *No.* When?
Years in bananas: *Eleven.* Life of farm: *Still good production.*
Years in bush or fallow: *Never.*
Other crops grown: *None.*

DISEASE HISTORY

When first noted: *1909.*
Age of plants when attacked: *About four years.*
Rapidity of spread: *Slow.*
Treatment given: *1912–13, liming, without digging out roots.*

OTHER DATA

	Surface—6"	6"—18"	18"—30"
Physical Examination			
Color	light brown	light brown	light brown
Compactness	loose	loose	loose
Friability	light	light	light
Retentive Power	73	66	66
Mechanical Examination			
Coarse gravel	0	0	0
Fine gravel	0	0	0
Coarse sand	9.0	16.3	10.9
Fine sand	12.6	17.6	20.7
Silt	72.7	60.1	62.0
Clay	5.7	6.0	6.4
Chemical Examination			
Organic matter	8.91	9.77	8.10
Total Nitrogen	.18	.15	.13
Potash (K_2O)	.23	.42	.11
Phosphoric acid (P_2O_5)	.24	.15	.27
Lime (CaO)	1.36	.67	2.27
Magnesia (MgO)	.13	0	.35
Iron (Fe_2O_3)	7.58	7.45	8.35
Alumina (Al_2O_3)	13.89	11.01	15.59
Silica, sol. (SiO_2)			
Free Acidity			
Mycological Examination			
Typical Fusaria	Soil is diseased		
Other Fusaria			

COSTA RICA DIVISION

SERIAL NUMBER *21*

Location: *Cristina* Farm, Section *43*. Date: *May, 1916.*

Other distinguishing features: *In experimental plot.* Collector: *L. W. W.*

NATURAL FEATURES

Topography: *Upland.*
Drainage: *Good.*
Flood conditions: *None.*
Silt deposition: *None.*
Type of forest growth: *Probably heavy.*

CULTIVATION HISTORY

When cleared and planted: *About 1895.*
Number of replantings: *Once.* Why? *Also much supplying.*
General condition when in production: *Good to bad.*
Plowed? *Yes.* When? *1910 and 1914.* Grubbed? *Yes.* When? *1914.*
Years in bananas: *About 20.* Life of farm: *Experimental area doing well.*
Years in bush or fallow: *In 1910 was in pasture.*
Other crops grown: *Coffee interplanted in 1915.*

DISEASE HISTORY

When first noted: *In the replanting of 1914 disease appeared in 1915.*
Age of plants when attacked: *Nearly a year old.*
Rapidity of spread: *Spread has been slow.*
Treatment given: *Cutting out diseased portion and fertilizing mats.*

OTHER DATA

Only a few mats had been fertilized at the time this sample was taken. Whole plot was fertilized six months later.

	Surface—6"	6"—18"	18"—30"
Physical Examination			
Color	dark brown	dark brown	light brown
Compactness	loose	loose	loose
Friability	heavy	heavy	heavy
Retentive Power	75	67	63
Mechanical Examination			
Coarse gravel	small rocks	small rocks	small rocks
Fine gravel	19.6	35.8	34.8
Coarse sand	21.4	17.6	13.8
Fine sand	27.4	31.9	23.4
Silt	22.8	7.3	21.4
Clay	8.8	7.4	6.6
Chemical Examination			
Organic matter	24.65	18.18	12.80
Total Nitrogen	.74	.29	.17
Potash (K_2O)	.58	.52	.56
Phosphoric acid (P_2O_5)	.67	.34	.47
Lime (CaO)	.58	.52	.56
Magnesia (MgO)	.57	.63	.69
Iron (Fe_2O_3)	8.65	10.78	10.14
Alumina (Al_2O_3)	11.99	18.18	18.32
Silica, sol. (SiO_2)			
Free Acidity			
Mycological Examination			
Typical Fusaria	Soil is heavily diseased		
Other Fusaria			

COSTA RICA DIVISION

SERIAL NUMBER *22*

Location: *Barmouth West* Farm, Section .

Other distinguishing features: *End of track.*

Date: *May, 1916.*

Collector: *L. W. W.*

NATURAL FEATURES

Topography: *Bottom land.*
Drainage: *Poor; water table too close to surface.*
Flood conditions: *Four or five times yearly.*
Silt deposition: *Heavy.*
Type of forest growth: *Heavy.*

CULTIVATION HISTORY

When cleared and planted: *About 1895.*
Number of replantings: *By supplying.* Why?
General condition when in production: *Good to bad.*
Plowed? *No.* When? Grubbed? *No.* When?
Years in bananas: *Twenty.* Life of farm: *Almost abandoned.*
Years in bush or fallow: *Never.*
Other crops grown: *None.*

DISEASE HISTORY

When first noted: *1907.*
Age of plants when attacked: *About two years.*
Rapidity of spread: *Medium until 1914, then rapid.*
Treatment given: *In 1911 digging out and liming.*

OTHER DATA

	Surface—6"	6"—18"	18"—30"
Physical Examination			
Color	light brown	light brown	light brown
Compactness	loose	loose	loose
Friability	light	light	light
Retentive Power	79	72	66
Mechanical Examination			
Coarse gravel	0	0	0
Fine gravel	53.6	5.2	9.2
Coarse sand	10.9	27.3	25.5
Fine sand	12.0	29.7	30.0
Silt	17.2	30.8	27.5
Clay	6.3	7.0	7.3
Chemical Examination			
Organic matter	12.49	11.03	10.32
Total Nitrogen	.22	.23	.18
Potash (K_2O)	.39	.57	.45
Phosphoric acid (P_2O_5)	.29	.28	.26
Lime (CaO)	2.41	2.42	2.28
Magnesia (MgO)	1.02	1.94	2.11
Iron (Fe_2O_3)	7.78	8.57	9.00
Alumina (Al_2O_3)	11.82	10.80	11.45
Silica, sol. (SiO_2)			
Free Acidity			
Mycological Examination			
Typical Fusaria	Soil is diseased		
Other Fusaria			

COSTA RICA DIVISION

SERIAL NUMBER *23*

Location: *Zent* Farm, Section *51*. Date: *May, 1916.*
Other distinguishing features: *Experimental plot.* Collector: *L. W. W.*

NATURAL FEATURES
Topography: *Bottom land.*
Drainage: *Good.*
Flood conditions: *Once every two or three years.*
Silt deposition: *Light.*
Type of forest growth: *Light cane.*

CULTIVATION HISTORY
When cleared and planted: *About 1895.*
Number of replantings: *By supplying.* Why?
General condition when in production: *Good until 1910.*
Plowed? *Yes.* When? *1910.* Grubbed? *No.* When?
Years in bananas: *About 15.* Life of farm: *Abandoned.*
Years in bush or fallow: *Never.*
Other crops grown: *None.*

DISEASE HISTORY
When first noted: *About 1901.*
Age of plants when attacked: *About six years.*
Rapidity of spread: *Slow until plowing and replanting of 1910, then rapid.*
Treatment given: *None.*

OTHER DATA
This area was taken as an experimental plot in 1914, then classed as abandoned land, but plants died from disease in less than a year. Only bunches which matured were those fertilized.

	Surface—6"	6"—18"	18"—30"
Physical Examination			
Color	light brown	light brown	light brown
Compactness	loose	loose	loose
Friability	light	light	light
Retentive Power	80	68	57
Mechanical Examination			
Coarse gravel	0	0	0
Fine gravel	.5	.4	0
Coarse sand	23.7	15.8	15.1
Fine sand	23.0	19.2	17.7
Silt	47.0	59.1	62.8
Clay	5.8	5.5	4.4
Chemical Examination			
Organic matter	11.01	7.67	7.75
Total Nitrogen	.31	.01	.07
Potash (K_2O)	.36	.35	.34
Phosphoric acid (P_2O_5)	.27	.20	.18
Lime (CaO)	1.45	1.52	1.94
Magnesia (MgO)	.93	.78	.78
Iron (Fe_2O_3)	7.45	8.05	8.62
Alumina (Al_2O_3)	9.73	11.04	12.62
Silica, sol. (SiO_2)			
Free Acidity			
Mycological Examination			
Typical Fusaria	Soil is heavily diseased		
Other Fusaria			

COSTA RICA DIVISION

SERIAL NUMBER *24*

Location: *Chirripo* Farm, Section *10.* Date: *May, 1916.*

Other distinguishing features: *Junction of tram.* Collector: *L. W. W.*

NATURAL FEATURES

Topography: *Bottom land.*
Drainage: *Fair.*
Flood conditions: *Every two or three years.*
Silt deposition: *Light.*
Type of forest growth: *Heavy.*

CULTIVATION HISTORY

When cleared and planted: *1901–2.*
Number of replantings: *One, 1908.* Why? *Also supplies.*
General condition when in production: *Good until 1908.*
Plowed? *Yes.* When? *1910.* Grubbed? *Yes.* When? *1910.*
Years in bananas: *About ten.* Life of farm: *Abandoned since 1914.*
Years in bush or fallow: *Since 1914.*
Other crops grown: *Congos in 1914.*

DISEASE HISTORY

When first noted: *1906.*
Age of plants when attacked: *About four years.*
Rapidity of spread: *Slow until floods of 1908.*
Treatment given: *Digging out, liming and mulching until replanting of 1910.*

OTHER DATA

The flood of 1908 washed top soil away instead of depositing silt.

	Surface—6"	6"—18"	18"—30"
Physical Examination			
Color	light brown	light brown	light brown
Compactness	loose	loose	loose
Friability	light	light	light
Retentive Power	51	52	33
Mechanical Examination			
Coarse gravel	0	0	0
Fine gravel	5.8	2.7	.7
Coarse sand	5.2	6.5	3.1
Fine sand	22.3	22.9	22.9
Silt	61.7	64.5	70.4
Clay	5.0	3.4	2.9
Chemical Examination			
Organic matter	8.02	6.20	5.48
Total Nitrogen	.17	.09	.05
Potash (K_2O)	.33	.22	.26
Phosphoric acid (P_2O_5)	.19	.23	.19
Lime (CaO)	2.10	2.10	2.02
Magnesia (MgO)	2.11	.78	.87
Iron (Fe_2O_3)	8.26	7.95	8.11
Alumina (Al_2O_3)	8.30	10.52	10.81
Silica, sol. (SiO_2)			
Free Acidity			
Mycological Examination			
Typical Fusaria	Soil is diseased		
Other Fusaria			

COSTA RICA DIVISION

SERIAL NUMBER *25*

Location: *Alaska* Farm, Section .

Date: *May, 1916.*

Other distinguishing features: *Planted by M. J. Carroll.*

Collector: *L. W. W.*

NATURAL FEATURES

Topography: *Bottom land.*
Drainage: *Water table low.*
Flood conditions: *Three or four times a year.*
Silt deposition: *Heavy.*
Type of forest growth: *Heavy.*

CULTIVATION HISTORY

When cleared and planted: *About 1900.*
Number of replantings: *By supplying.* Why?
General condition when in production: *Good.*
Plowed? *No.* When? Grubbed? *No.* When?
Years in bananas: *Fifteen.* Life of farm: *Still good producer.*
Years in bush or fallow: *Never.*
Other crops grown: *None.*

DISEASE HISTORY

When first noted: *1906.*
Age of plants when attacked: *About six years.*
Rapidity of spread: *Slow.*
Treatment given: *None.*

OTHER DATA

	Surface—6″	6″—18″	18″—30″
Physical Examination			
Color	light brown	light brown	light brown
Compactness	loose	loose	loose
Friability	light	light	light
Retentive Power	82	69	64
Mechanical Examination			
Coarse gravel	0	0	0
Fine gravel	54.1	16.9	15.0
Coarse sand	12.9	20.7	16.3
Fine sand	12.9	26.7	23.6
Silt	12.0	27.3	36.0
Clay	8.1	8.4	9.1
Chemical Examination			
Organic matter	13.85	10.92	9.93
Total Nitrogen	.29	.18	.12
Potash (K_2O)	.41	.48	.67
Phosphoric acid (P_2O_5)	.32	.18	.24
Lime (CaO)	3.06	2.71	2.42
Magnesia (MgO)	1.17	.92	2.68
Iron (Fe_2O_3)	8.05	11.31	8.75
Alumina (Al_2O_3)	13.19	10.16	12.61
Silica, sol. (SiO_2)			
Free Acidity			
Mycological Examination			
Typical Fusaria	Soil is diseased		
Other Fusaria			

COSTA RICA DIVISION

SERIAL NUMBER *26*

Location: *Vesta* Farm, Section *; 39 Mile.*

Date: *May, 1916.*

Other distinguishing features:

Collector: *L. W. W.*

NATURAL FEATURES

Topography: *Bottom land.*
Drainage: *Good.*
Flood conditions: *Once a year.*
Silt deposition: *None.*
Type of forest growth: *Heavy.*

CULTIVATION HISTORY

When cleared and planted: *1914.*
Number of replantings: *Once.* Why? *In 1914 because of flood.*
General condition when in production: *Good.*
Plowed? *No.* When? Grubbed? *No.* When?
Years in bananas: *Two.* Life of farm: *Good producer.*
Years in bush or fallow: *Never.*
Other crops grown: *None.*

DISEASE HISTORY

When first noted: *1915.*
Age of plants when attacked: *About a year old.*
Rapidity of spread: *Slow.*
Treatment given: *Digging out and bleaching.*

OTHER DATA

	Surface—6"	6"—18"	18"—30"
Physical Examination			
Color	dark brown	light brown	light brown
Compactness	loose	loose	loose
Friability	light	light	light
Retentive Power	82	68	51
Mechanical Examination			
Coarse gravel	0	0	0
Fine gravel	6.0	6.9	19.8
Coarse sand	27.9	16.8	20.1
Fine sand	26.1	26.0	27.0
Silt	36.4	45.0	26.8
Clay	3.6	5.3	6.3
Chemical Examination			
Organic matter	15.81	11.08	8.10
Total Nitrogen	.46	.23	.08
Potash (K_2O)	.39	.32	.54
Phosphoric acid (P_2O_5)	.22	.23	.21
Lime (CaO)	2.11	1.75	1.66
Magnesia (MgO)	1.37	1.66	1.31
Iron (Fe_2O_3)	6.72	8.06	10.97
Alumina (Al_2O_3)	10.25	12.18	12.29
Silica, sol. (SiO_2)			
Free Acidity			
Mycological Examination			
Typical Fusaria	Soil is diseased		
Other Fusaria			

COSTA RICA DIVISION

SERIAL NUMBER 27

Location: *Venetia* Farm, Section *10.* Date: *May, 1916.*
Other distinguishing features: *Experimental plot.* Collector: *L. W. W.*

NATURAL FEATURES

Topography: *Bottom land.*
Drainage: *Poor, high water table.*
Flood conditions: *None.*
Silt deposition: *None.*
Type of forest growth: *Heavy.*

CULTIVATION HISTORY

When cleared and planted: *1903–4.*
Number of replantings: *One.* Why? *Disease.*
General condition when in production: *Good for about 4 years, bad after replanting.*
Plowed? *Yes.* When? *1909.* Grubbed? *Yes.* When? *1909.*
Years in bananas: *About seven.* Life of farm: *Abandoned 1912.*
Years in bush or fallow: *1912 to 1914.*
Other crops grown: *Some cacao.*

DISEASE HISTORY

When first noted: *About 1904.*
Age of plants when attacked: *About a year.*
Rapidity of spread: *Medium to rapid.*
Treatment given: *Liming.*

OTHER DATA

This area was taken as an experimental plot in 1914 after being abandoned for two years. Disease appeared in about six months and production was never good even though fertilizer was used.

	Surface—6"	6"—18"	18"—30"
Physical Examination			
Color	light brown	light brown	light brown
Compactness	hard	hard	hard
Friability	refractory	refractory	refractory
Retentive Power	86	77	79
Mechanical Examination			
Coarse gravel	0	0	0
Fine gravel	0	1.0	0
Coarse sand	26.1	26.1	26.3
Fine sand	33.3	26.6	29.0
Silt	34.6	40.6	40.7
Clay	6.0	5.7	4.0
Chemical Examination			
Organic matter	12.17	7.75	7.63
Total Nitrogen	.33	.11	.09
Potash (K_2O)	.34	.49	.44
Phosphoric acid (P_2O_5)	.24	.29	.23
Lime (CaO)	1.34	2.22	2.01
Magnesia (MgO)	.26	2.11	2.36
Iron (Fe_2O_3)	8.48	9.12	9.27
Alumina (Al_2O_3)	15.59	10.82	11.71
Silica, sol. (SiO_2)			
Free Acidity			
Mycological Examination			
Typical Fusaria	Soil heavily diseased		
Other Fusaria			

COSTA RICA DIVISION

SERIAL NUMBER *28*

Location: *Blanco* Farm, Section . Date: *May, 1916.*

Other distinguishing features: *Riverbank in front of house.* Collector: *L. W. W.*

NATURAL FEATURES

Topography: *Valley.*
Drainage: *Good.*
Flood conditions: *Three or four times a year.*
Silt deposition: *Heavy.*
Type of forest growth: *Heavy.*

CULTIVATION HISTORY

When cleared and planted: *1906–7.*
Number of replantings: *Two.* Why? *By supplying.*
General condition when in production: *Good until 1910, then decreased.*
Plowed? *No.* When? Grubbed? *No.* When?
Years in bananas: *About ten.* Life of farm: *Production decreasing.*
Years in bush or fallow: *Never.*
Other crops grown: *None.*

DISEASE HISTORY

When first noted: *1910.*
Age of plants when attacked: *Four years.*
Rapidity of spread: *Slow until 1910, then rapid.*
Treatment given: *None.*

OTHER DATA

	Surface—6"	6"—18"	18"—30"
Physical Examination			
Color	brown	brown	brown
Compactness	loose	loose	loose
Friability	light	light	light
Retentive Power	67	63	58
Mechanical Examination			
Coarse gravel	0	0	0
Fine gravel	0	2.0	3.7
Coarse sand	10.6	12.2	13.9
Fine sand	27.1	34.3	34.2
Silt	56.9	47.0	42.8
Clay	5.4	4.5	5.4
Chemical Examination			
Organic matter	6.18	7.05	8.14
Total Nitrogen	.17	.12	.12
Potash (K_2O)	.35	.67	.60
Phosphoric acid (P_2O_5)	.29	.19	.21
Lime (CaO)	3.14	3.91	4.60
Magnesia (MgO)	.50	.41	.94
Iron (Fe_2O_3)	5.45	8.19	7.05
Alumina (Al_2O_3)	7.71	6.39	6.13
Silica, sol. (SiO_2)			
Free Acidity			
Mycological Examination			
Typical Fusaria	Soil is diseased		
Other Fusaria			

COSTA RICA DIVISION

SERIAL NUMBER *29*

Location: *Parismina* Farm, Section .
Other distinguishing features: *End of track.*

Date: *May, 1916.*
Collector: *L. W. W.*

NATURAL FEATURES

Topography: *Bottom land.*
Drainage: *Poor.*
Flood conditions: *None.*
Silt deposition: *None.*
Type of forest growth: *Heavy.*

CULTIVATION HISTORY

When cleared and planted: *1914.*
Number of replantings: *None.* Why?
General condition when in production: *Just come into bearing, indications good.*
Plowed? *No.* When? Grubbed? *No* When?
Years in bananas: *Two.* Life of farm:
Years in bush or fallow: *Never.*
Other crops grown: *None.*

DISEASE HISTORY

When first noted: *1915.*
Age of plants when attacked: *Nine months old.*
Rapidity of spread: *Appears to be spreading rapidly.*
Treatment given: *Liming.*

OTHER DATA

	Surface—6"	6"—18"	18"—30"
Physical Examination			
Color	dark brown	dark brown	light brown
Compactness	hard	hard	hard
Friability	heavy	heavy	heavy
Retentive Power	87	73	56
Mechanical Examination			
Coarse gravel	0	0	0
Fine gravel	47.6	9.9	3.6
Coarse sand	16.5	11.2	4.2
Fine sand	20.6	31.2	24.5
Silt	7.2	39.5	62.7
Clay	8.1	8.2	5.0
Chemical Examination			
Organic matter	27.95	20.62	21.00
Total Nitrogen	.84	.55	.13
Potash (K_2O)	.39	.80	.11
Phosphoric acid (P_2O_5)	.55	.47	.16
Lime (CaO)	.62	.37	.44
Magnesia (MgO)	1.00	1.35	1.56
Iron (Fe_2O_3)	8.00	10.00	9.90
Alumina (Al_2O_3)	14.06	13.79	11.82
Silica, sol. (SiO_2)			
Free Acidity			
Mycological Examination			
Typical Fusaria	Soil is diseased		
Other Fusaria			

COSTA RICA DIVISION

SERIAL NUMBER *30*

Location: *San Cecilio* Farm, Section *3*.

Date: *May, 1916.*

Collector: *L. W. W.*

Other distinguishing features:

NATURAL FEATURES

Topography: *Upland.*
Drainage: *Good.*
Flood conditions: *None.*
Silt deposition: *None.*
Type of forest growth: *Heavy.*

CULTIVATION HISTORY

When cleared and planted: *Latter part 1912.*
Number of replantings: *None.* Why?
General condition when in production: *Good.*
Plowed? *No.* When? Grubbed? *No.* When?
Years in bananas: *Four.* Life of farm: *Production still good.*
Years in bush or fallow: *Never.*
Other crops grown: *None.*

DISEASE HISTORY

When first noted: *1913.*
Age of plants when attacked: *About a year.*
Rapidity of spread: *Slow.*
Treatment given: *None.*

OTHER DATA

This land had for several years been cultivated in plantains by negro squatters.

	Surface—6"	6"—18"	18"—30"
Physical Examination			
Color	red brown	red brown	red brown
Compactness	hard	hard	hard
Friability	heavy	heavy	heavy
Retentive Power	79	77	73
Mechanical Examination			
Coarse gravel	0	0	0
Fine gravel	0	1.2	0
Coarse sand	22.1	20.1	16.6
Fine sand	28.2	28.1	25.1
Silt	44.2	46.1	53.2
Clay	5.5	4.5	5.1
Chemical Examination			
Organic matter	13.48	9.02	8.50
Total Nitrogen	.34	.12	.11
Potash (K_2O)	.35	.34	.35
Phosphoric acid (P_2O_5)	.29	.16	.15
Lime (CaO)	.97	.90	.87
Magnesia (MgO)	.58	.78	.70
Iron (Fe_2O_3)	9.22	11.52	8.61
Alumina (Al_2O_3)	8.71	7.84	11.22
Silica, sol. (SiO_2)			
Free Acidity			
Mycological Examination			
Typical Fusaria	Soil is diseased		
Other Fusaria			

COSTA RICA DIVISION

SERIAL NUMBER *31*

Location: *Zent* Farm, Section *10*. Date: *May, 1916.*

Other distinguishing features: *Cotton plot.* Collector: *L. W. W.*

NATURAL FEATURES

Topography: *Valley.*
Drainage: *Good.*
Flood conditions: *None.*
Silt deposition: *None.*
Type of forest growth: *Probably heavy.*

CULTIVATION HISTORY

When cleared and planted: *About 1895.*
Number of replantings: *None.* Why?
General condition when in production: *Good.*
Plowed? *Yes.* When? *1910.* Grubbed? *Yes.* When? *1910.*
Years in bananas: *Twenty.* Life of farm: *Now used as garden.*
Years in bush or fallow: *Never.*
Other crops grown: *Truck garden, castor beans, eucalyptus, papayas, etc., and was supplied with natural fertilizer.*

DISEASE HISTORY

When first noted: *About 1901.*
Age of plants when attacked: *About six years.*
Rapidity of spread: *Slow.*
Treatment given: *None.*

OTHER DATA

	Surface—6"	6"—18"	18"—30"
Physical Examination			
Color	dark brown	dark brown	dark brown
Compactness	loose	loose	loose
Friability	light	light	light
Retentive Power	58	50	50
Mechanical Examination			
Coarse gravel	0	0	0
Fine gravel	0.4	0.3	0
Coarse sand	7.9	10.0	7.2
Fine sand	34.5	47.4	38.2
Silt	52.8	39.1	50.7
Clay	4.4	3.2	3.9
Chemical Examination			
Organic matter	7.84	6.25	5.48
Total Nitrogen	.13	.09	.05
Potash (K_2O)	.38	.22	.25
Iron (Fe_2O_3)	.30	.26	.22
Lime (CaO)	1.97	2.08	2.28
Magnesia (MgO)	2.32	1.91	.60
Iron (Fe_2O_3)	8.17	8.17	7.97
Alumina (Al_2O_3)	9.93	10.63	12.25
Silica, sol. (SiO_2)			
Free Acidity			
Mycological Examination			
Typical Fusaria	Soil is diseased		
Other Fusaria			

COSTA RICA DIVISION

SERIAL NUMBER *32*

Location: *Livingston* Farm, Section *o-B.* Date: *May, 1916.*

Other distinguishing features: *Cotton plot.* Collector: *L. W. W.*

NATURAL FEATURES

Topography: *Bottom land.*
Drainage: *Good.*
Flood conditions: *Two or three times a year.*
Silt deposition: *Heavy.*
Type of forest growth: *Wild cane.*

CULTIVATION HISTORY

When cleared and planted: *1900.*
Number of replantings: *Three.* Why? *Flood damage.*
General condition when in production: *Good.*
Plowed? *No.* When? Grubbed? *No.* When?
Years in bananas: *Sixteen.* Life of farm: *Experimental plot.*
Years in bush or fallow: *Never.*
Other crops grown: *None.*

DISEASE HISTORY

When first noted: *1913.*
Age of plants when attacked: *One year; supplies after heavy flood.*
Rapidity of spread: *Slow.*
Treatment given: *None.*

OTHER DATA

	Surface—6"	6"—18"	18"—30"
Physical Examination			
Color	light brown	light brown	light brown
Compactness	loose	loose	loose
Friability	sandy	sandy	sandy
Retentive Power	48	30	37
Mechanical Examination			
Coarse gravel	0	0	0
Fine gravel	2.5	3.7	2.3
Coarse sand	6.7	12.3	9.6
Fine sand	43.9	50.5	53.2
Silt	42.8	31.4	32.8
Clay	4.1	2.1	2.1
Chemical Examination			
Organic matter	7.37	3.89	3.89
Total Nitrogen	.18	.08	.04
Potash (K_2O)	.24	.36	.40
Phosphoric acid (P_2O_5)	.35	.05	.12
Lime (CaO)	1.98	2.12	1.98
Magnesia (MgO)	1.50	1.93	2.08
Iron (Fe_2O_3)	9.93	14.00	9.58
Alumina (Al_2O_3)	10.29	4.03	7.14
Silica, sol. (SiO_2)			
Free Acidity			
Mycological Examination			
Typical Fusaria	Soil is diseased		
Other Fusaria			

COSTA RICA DIVISION

SERIAL NUMBER *33*

Location: *Bristol* Farm, Section *28*.
Other distinguishing features: *Cotton plot.*

Date: *May, 1916.*
Collector: *L. W. W.*

NATURAL FEATURES

Topography: *Bottom land.*
Drainage: *Good.*
Flood conditions: *About every two years.*
Silt deposition: *None.*
Type of forest growth: *Probably heavy.*

CULTIVATION HISTORY

When cleared and planted: *About 1900 by squatters.*
Number of replantings: *None.* Why? *Taken as pasture several years ago.*
General condition when in production: *Good.*
Plowed? *No.* When? Grubbed? *No.* When?
Years in bananas: *A few.* Life of farm:
Years in bush or fallow: *Pasture for several years.*
Other crops grown: *None.*

DISEASE HISTORY

When first noted: *In farm about 1907.*
Age of plants when attacked: *In squatter plantings, age unknown.*
Rapidity of spread: *Slow.*
Treatment given: *None.*

OTHER DATA

	Surface—6"	6"—18"	18"—30"
Physical Examination			
Color	light brown	light brown	light brown
Compactness	loose	loose	loose
Friability	light	light	light
Retentive Power	65	65	59
Mechanical Examination			
Coarse gravel	0	0	0
Fine gravel	7.8	17.7	2.6
Coarse sand	13.3	16.8	13.8
Fine sand	24.6	25.9	24.1
Silt	48.8	34.2	54.0
Clay	5.5	5.4	5.5
Chemical Examination			
Organic matter	10.32	7.85	9.93
Total Nitrogen	.22	.09	.11
Potash (K_2O)	.36	.78	.45
Phosphoric acid (P_2O_5)	.22	.19	.22
Lime (CaO)	2.03	1.96	1.74
Magnesia (MgO)	2.29	2.94	2.46
Iron (Fe_2O_3)	9.14	9.31	8.53
Alumina (Al_2O_3)	11.32	11.72	11.42
Silica, sol. (SiO_2)			
Free Acidity			
Mycological Examination			
Typical Fusaria	Soil is diseased		
Other Fusaria			

COSTA RICA DIVISION

SERIAL NUMBER *34*

Location: *Philadelphia South* Farm, Section *; By house.*

Date: *May, 1916.*

Collector: *L. W. W.*

Other distinguishing features: *Cotton plot.*

NATURAL FEATURES

Topography: *Hilltop.*
Drainage: *Good.*
Flood conditions: *None.*
Silt deposition: *None.*
Type of forest growth: *Heavy.*

CULTIVATION HISTORY

When cleared and planted: *Never planted, always part of house yard.*
Number of replantings: Why?
General condition when in production:
Plowed? When? Grubbed? When?
Years in bananas: Life of farm:
Years in bush or fallow:
Other crops grown:

DISEASE HISTORY

When first noted: *No bananas grown.*
Age of plants when attacked:
Rapidity of spread:
Treatment given:

OTHER DATA

	Surface—6"	6"—18"	18"—30"
Physical Examination			
Color	red yellow	red yellow	red yellow
Compactness	hard	hard	hard
Friability	refractory	refractory	refractory
Retentive Power	70	69	70
Mechanical Examination			
Coarse gravel	0	0	0
Fine gravel	0	1.8	0
Coarse sand	22.0	24.7	25.5
Fine sand	30.4	31.6	32.5
Silt	43.8	39.0	39.4
Clay	3.8	2.9	2.6
Chemical Examination			
Organic matter	10.34	9.79	11.26
Total Nitrogen	.18	.15	.10
Potash (K_2O)	.14	.14	.04
Phosphoric acid (P_2O_5)	.08	.08	.08
Lime (CaO)	.25	.10	.45
Magnesia (MgO)	.22	.06	0
Iron (Fe_2O_3)	10.31	10.86	13.10
Alumina (Al_2O_3)	13.82	14.68	16.64
Silica, sol. (SiO_2)			
Free Acidity			
Mycological Examination			
Typical Fusaria	Soil is diseased		
Other Fusaria			

COSTA RICA DIVISION

SERIAL NUMBER *35*

Location: *San Andreas* Farm, Section . Date: *May, 1916.*

Other distinguishing features: *Cotton plot.* Collector: *L. W. W.*

NATURAL FEATURES

Topography: *Bottom land.*
Drainage: *Good.*
Flood conditions: *None.*
Silt deposition: *None.*
Type of forest growth: *Heavy.*

CULTIVATION HISTORY

When cleared and planted: *1911–12.*
Number of replantings: *None.* Why?
General condition when in production: *Poor.*
Plowed? *No.* When? Grubbed? *No.* When?
Years in bananas: *Four.* Life of farm: *This spot gave poor results.*
Years in bush or fallow: *Never.*
Other crops grown: *None.*

DISEASE HISTORY

When first noted: *Latter part of 1913.*
Age of plants when attacked: *About one year.*
Rapidity of spread: *Rapid.*
Treatment given: *None.*

OTHER DATA

	Surface—6"	6"—18"	18"—30"
Physical Examination			
Color	light brown	light brown	light brown
Compactness	loose	loose	loose
Friability	light	light	light
Retentive Power	66	70	67
Mechanical Examination			
Coarse gravel	0	0	0
Fine gravel	0	0	0
Coarse sand	15.4	12.6	18.0
Fine sand	32.4	28.2	27.0
Silt	46.6	54.1	49.2
Clay	5.6	5.1	6.0
Chemical Examination			
Organic matter	10.60	10.12	8.73
Total Nitrogen	0	.13	.14
Potash (K_2O)	.39	.14	.31
Phosphoric acid (P_2O_5)	.11	.19	.10
Lime (CaO)	.45	2.27	.56
Magnesia (MgO)	1.74	.93	2.08
Iron (Fe_2O_3)	8.49	7.18	8.33
Alumina (Al_2O_3)	12.31	8.83	7.25
Silica, sol. (SiO_2)			
Free Acidity			
Mycological Examination			
Typical Fusaria	Soil is diseased		
Other Fusaria			

COSTA RICA DIVISION

SERIAL NUMBER *36*

Location: *Bananito North* Farm, Section *38*. Date: *May, 1916.*

Other distinguishing features: *Cotton plot.* Collector: *L. W. W.*

NATURAL FEATURES

Topography: *Bottom land.*
Drainage: *Good.*
Flood conditions: *Two to three times a year.*
Silt deposition: *Six to eight inches.*
Type of forest growth: *Heavy.*

CULTIVATION HISTORY

When cleared and planted: *1906.*
Number of replantings: *None.* Why?
General condition when in production: *Good.*
Plowed? *No.* When? Grubbed? *No.* When?
Years in bananas: *About ten.* Life of farm: *Still good.*
Years in bush or fallow: *Never.*
Other crops grown: *None.*

DISEASE HISTORY

When first noted: *About 1908.*
Age of plants when attacked: *Two years.*
Rapidity of spread: *Slow.*
Treatment given: *None.*

OTHER DATA

	Surface—6″	6″—18″	18″—30″
Physical Examination			
Color	light brown	light brown	light brown
Compactness	loose	loose	loose
Friability	light	light	light
Retentive Power	66	70	67
Mechanical Examination			
Coarse gravel	0	0	0
Fine gravel	0	1.3	0
Coarse sand	11.1	11.1	7.0
Fine sand	14.0	14.5	16.0
Silt	70.7	68.8	72.7
Clay	4.2	4.3	4.3
Chemical Examination			
Organic matter	7.24	7.14	6.74
Total Nitrogen	.11	.12	.10
Potash (K_2O)	.27	.23	.21
Phosphoric acid (P_2O_5)	.15	.14	.16
Lime (CaO)	2.32	1.26	2.38
Magnesia (MgO)	.74	.30	.81
Iron (Fe_2O_3)	7.95	8.31	8.49
Alumina (Al_2O_3)	8.87	9.75	7.78
Silica, sol. (SiO_2)			
Free Acidity			
Mycological Examination			
Typical Fusaria	Soil is diseased		
Other Fusaria			

COSTA RICA DIVISION

SERIAL NUMBER *37*

Location: *Colombiana* Farm, Section *15*. Date: *May, 1916.*

Other distinguishing features: *Cotton plot.* Collector: *L. W. W.*

NATURAL FEATURES

Topography: *Upland.*
Drainage: *Good.*
Flood conditions: *None.*
Silt deposition: *None.*
Type of forest growth: *Heavy.*

CULTIVATION HISTORY

When cleared and planted: *1900.*
Number of replantings: *None.* Why?
General condition when in production: *Poor.*
Plowed? *Yes.* When? *1900–4.* Grubbed? *Yes.* When? *1900–4.*
Years in bananas: *Four.* Life of farm: *Abandoned 1904.*
Years in bush or fallow: *Pasture since 1904.*
Other crops grown: *Some native tobacco.*

DISEASE HISTORY

When first noted: *No data.*
Age of plants when attacked:
Rapidity of spread:
Treatment given:

OTHER DATA

	Surface—6″	6″—18″	18″—30″
Physical Examination			
Color	dark brown	dark brown	dark brown
Compactness	hard	hard	hard
Friability	refractory	refractory	refractory
Retentive Power	60	61	55
Mechanical Examination			
Coarse gravel	0	small stones	small stones
Fine gravel	16.7	15.0	10.5
Coarse sand	18.2	20.9	19.4
Fine sand	28.1	32.8	32.0
Silt	30.4	26.2	32.7
Clay	6.6	5.1	5.4
Chemical Examination			
Organic matter	23.25	18.95	17.90
Total Nitrogen	.28	.20	.15
Potash (K_2O)	.16	.20	.17
Phosphoric acid (P_2O_5)	.18	.31	.31
Lime (CaO)	.28	.17	.17
Magnesia (MgO)	.15	.13	.24
Iron (Fe_2O_3)	15.81	15.41	16.69
Alumina (Al_2O_3)	30.21	33.08	33.00
Silica, sol. (SiO_2)			
Free Acidity			
Mycological Examination			
Typical Fusaria	Soil is diseased		
Other Fusaria			

COSTA RICA DIVISION

SERIAL NUMBER *38*

Location: *Salvador* Farm, Section .
Other distinguishing features: *Cotton plot.*

Date: *May, 1916.*
Collector: *L. W. W.*

NATURAL FEATURES

Topography: *Upland.*
Drainage: *Good.*
Flood conditions: *None.*
Silt deposition: *None.*
Type of forest growth: *Heavy.*

CULTIVATION HISTORY

When cleared and planted: *Originally in sugar cane, but abandoned 25 years or more ago.*
Number of replantings: Why?
General condition when in production:
Plowed? When? Grubbed? When?
Years in bananas: Life of farm:
Years in bush or fallow:
Other crops grown:

DISEASE HISTORY

When first noted: *No data.*
Age of plants when attacked:
Rapidity of spread:
Treatment given:

OTHER DATA

	Surface—6″	6″—18″	18″—30″
PHYSICAL EXAMINATION			
Color	black	dark brown	dark brown
Compactness	hard	hard	hard
Friability	heavy	heavy	heavy
Retentive Power	82	57	54
MECHANICAL EXAMINATION			
Coarse gravel	small stones	0	small stones
Fine gravel	16.2	15.0	18.7
Coarse sand	22.0	14.2	14.5
Fine sand	33.2	31.7	32.7
Silt	21.9	31.8	29.7
Clay	6.7	7.3	4.4
CHEMICAL EXAMINATION			
Organic matter	20.15	15.62	9.83
Total Nitrogen	.42	.42	.21
Potash (K_2O)	.46	.06	.39
Phosphoric acid (P_2O_5)	.33	.14	.19
Lime (CaO)	.53	.56	.79
Magnesia (MgO)	.87	.94	1.08
Iron (Fe_2O_3)	8.07	7.25	7.35
Alumina (Al_2O_3)	8.18	8.88	9.07
Silica, sol. (SiO_2)			
Free Acidity			
MYCOLOGICAL EXAMINATION			
Typical Fusaria	Soil is diseased		
Other Fusaria			

COSTA RICA DIVISION

SERIAL NUMBER *39*

Location: *Bearesem West* Farm, Section . Date: *May, 1916.*

Other distinguishing features: *Mulched area.* Collector: *L. W. W.*

NATURAL FEATURES

Topography: *Bottom land.*
Drainage: *Good.*
Flood conditions: *Once a year.*
Silt deposition: *Slight.*
Type of forest growth: *Probably heavy.*

CULTIVATION HISTORY

When cleared and planted: *1900.*
Number of replantings: *None.* Why?
General condition when in production: *Good until 1914.*
Plowed? *No.* When? Grubbed? *No.* When?
Years in bananas: *Sixteen.* Life of farm: *Production falling off.*
Years in bush or fallow: *Never.*
Other crops grown: *None.*

DISEASE HISTORY

When first noted: *1909.*
Age of plants when attacked: *Nine years.*
Rapidity of spread: *Slow until 1913, then rapid.*
Treatment given: *Mulching in 1916.*

OTHER DATA

This area has been covered with a heavy mulch of banana trash from cars.

	Surface—6"	6"—18"	18"—30"
Physical Examination			
Color	light brown	light brown	light brown
Compactness	loose	loose	loose
Friability	light	light	light
Retentive Power	73	72	69
Mechanical Examination			
Coarse gravel	0	0	0
Fine gravel	0	0	0
Coarse sand	11.9	12.9	19.7
Fine sand	26.6	23.3	26.8
Silt	54.3	58.3	47.3
Clay	7.2	5.5	6.2
Chemical Examination			
Organic matter	9.78	8.11	6.90
Total Nitrogen	.01	.16	.15
Potash (K_2O)	.37	.25	.09
Phosphoric acid (P_2O_5)	.24	.28	.19
Lime (CaO)	1.92	3.02	1.66
Magnesia (MgO)	1.08	1.94	1.67
Iron (Fe_2O_3)	7.12	8.32	6.94
Alumina (Al_2O_3)	10.41	12.43	11.43
Silica, sol. (SiO_2)			
Free Acidity			
Mycological Examination			
Typical Fusaria	Soil is diseased		
Other Fusaria			

Average Analyses—Costa Rica

Sample	Fine Gravel	Coarse Sand	Fine Sand	Silt	Clay	K_2O	CaO	MgO	Fe_2O_3	P_2O_5	Vol. Mat.	Tot. N	RP
Walkyria	2.5	7.6	41.1	43.9	4.9	.16	.85	.54	6.06	.29	9.36	.25	51
Precipicio	1.6	24.9	34.8	34.5	4.2	.09	.00	.00	12.92	.29	16.68	.23	63
Las Mercedes	36.1	17.8	23.9	15.5	6.7	.30	.57	.38	7.66	.72	18.65	.29	73
America	52.3	15.7	17.1	8.5	6.4	.15	.05	.03	15.19	.32	21.70	.13	63
Louisiana	26.9	19.1	26.0	22.0	6.0	.21	.17	.38	12.57	.41	19.65	.13	60
La Amelia	0.2	27.9	26.5	38.9	6.5	.44	1.55	.51	8.06	.33	9.70	.21	76
Carmen	0	11.1	17.4	66.2	5.3	.35	2.45	.91	6.59	.33	9.20	.15	79
La Lola	2.3	19.5	35.1	37.5	5.6	.19	1.77	1.17	10.56	.22	9.77	.16	67
Baltimore	7.9	9.2	19.8	58.4	4.7	.29	1.74	1.99	8.43	.15	8.79	.17	53
Bristol	12.7	12.7	21.7	48.3	4.6	.30	1.69	1.54	8.51	.28	11.07	.22	62
Luisa East	33.8	15.5	23.5	20.0	7.2	.40	2.02	1.81	9.15	.19	11.45	.21	74
Philadelphia North	0	10.7	19.4	65.7	4.2	.38	1.86	.88	8.49	.15	7.91	.12	58
Bananito South	0	9.2	22.1	63.8	4.9	.31	1.59	.73	8.43	.18	8.46	.14	65
San Clemente	0.7	22.9	30.1	40.8	5.5	.38	1.17	.52	9.95	.19	10.22	.21	74
Pandora	18.2	19.3	21.3	34.6	6.6	.41	1.23	1.00	8.03	.21	10.81	.29	70
Fortuna	9.8	17.3	23.9	42.2	6.8	.54	2.36	2.18	8.37	.24	10.42	.17	67
Aurora	9.3	9.8	26.5	50.1	4.3	.65	2.09	1.76	7.38	.21	8.40	.12	53
Talia	6.9	25.7	28.1	32.6	6.7	.41	2.31	1.91	7.96	.25	11.75	.22	68
Indiana I.	0	6.4	30.7	58.5	4.4	.07	1.33	.60	9.79	.08	9.19	.06	52
Indiana III.	0	12.7	17.8	63.4	6.1	.26	1.45	.17	7.83	.21	8.93	.15	67
Cristina	32.1	16.8	23.6	20.1	7.4	.26	.55	.64	10.10	.46	17.32	.33	67
Barmouth West	16.5	23.3	26.5	26.8	6.9	.49	2.36	1.82	8.58	.27	11.04	.21	71
Zent	0.3	17.1	19.3	58.2	5.1	.35	1.67	.81	8.16	.21	8.37	.09	66
Chirripo	2.5	4.9	22.8	66.3	3.5	.26	2.07	1.08	8.08	.21	6.27	.09	44

Alaska	23.6	17.4	22.7	27.7	8.6	.54	2.66	1.67	9.63	.23	11.11	.18	69
Vesta	11.9	20.3	26.4	34.1	7.3	.42	1.79	1.46	8.96	.22	10.83	.21	64
Venetia	0.4	26.2	28.9	39.4	5.1	.44	1.96	1.84	9.05	.26	8.59	.15	79
Blanco	2.3	12.6	32.8	47.3	5.0	.58	4.03	.64	7.19	.22	7.31	.13	62
Parismina	14.9	9.5	26.4	42.3	6.9	.44	.45	1.36	9.56	.36	22.24	.44	69
San Cecilio	0.5	19.1	27.0	48.5	4.9	.35	.90	.71	9.89	.18	9.70	.16	76
Zent	0.2	8.5	41.1	46.5	3.7	.26	2.14	1.47	8.09	.25	6.26	.08	51
Livingston	2.9	10.1	50.3	34.2	2.5	.35	2.03	1.90	11.24	.14	4.58	.08	36
Bristol	9.7	14.9	24.9	45.0	5.5	.56	1.88	2.62	8.96	.21	9.17	.12	63
Philadelphia South	0.7	24.5	31.7	40.1	3.0	.10	.27	.07	11.65	.08	10.49	.13	70
San Andreas	0	15.3	28.5	50.6	5.6	.26	1.22	1.55	7.90	.14	9.66	.11	68
Bananito North	0.5	9.5	15.0	70.7	4.3	.23	1.92	.59	8.31	.15	7.24	.11	69
Colombiana	13.5	19.8	31.6	29.6	5.5	.18	.19	.18	16.00	.28	19.39	.19	58
Salvador	15.7	15.9	32.4	30.0	6.0	.27	.65	.98	7.45	.20	14.21	.33	61
Bearesem West	0	15.4	25.4	53.1	6.1	.21	2.25	1.66	7.53	.23	7.96	.13	71
Whole Division	8.6	15.9	26.8	43.2	5.5	.34	1.54	1.07	9.08	.24	10.90	.20	63

AVERAGE OF RESULTS BY DISTRICTS

Santa Clara	21.7	16.4	28.6	27.3	6.0	.23	.39	.50	10.83	.37	17.69	.37	63
Siquirres	0.6	13.6	28.6	52.2	5.0	.29	1.78	.82	8.70	.22	8.32	.13	62
Zent	9.4	15.2	26.6	43.4	5.4	.39	2.17	1.54	8.70	.23	9.10	.15	63
Banana R	0.3	15.8	24.9	54.2	4.8	.28	1.39	.84	9.02	.16	8.95	.14	69
Estrella	11.2	18.5	25.3	38.7	6.3	.49	1.95	1.66	8.14	.23	10.44	.20	64

Ratio of Lime to Magnesia

In the following table will be found the ratios of lime to magnesia for the individual farms. For the most satisfactory results this ratio should be from 5:1, although much larger excesses of lime over magnesia are not harmful. It will be noted that in some instances there is an excess of magnesia over lime, and while this is generally regarded as objectionable, it seems to be typical of many soils where excellent crops of bananas have been grown. In general it will be noted that in this Division ratios of lime to magnesia are satisfactory. The three ratios given under each farm represent the ratios found in the three depths of soil taken for analysis.

For convenience, the tables—Ratio of Lime to Magnesia—give the ratios in the form 1–1, 3–1, etc., the magnesia being taken as unity in each case.

Ratio of Lime to Magnesia

1–1 to 5–1 regarded as normal

1. Walkyria	5. Louisiana	9. Baltimore
2-1	.50-1	1.5 -1
1-1	.33-1	.9 -1
23-1	.50-1	.66-1
2. Precipicio	6. La Amelia	10. Bristol
0	4-1	3-1
	3-1	.9-1
3. Las Mercedes	3-1	1-1
3-1	7. Carmen	11. Luisa E.
1-1	3-1	2-1
4-1	2-1	2-1
	4-1	.6-1
4. America	8. La Lola	12. Philadelphia N.
2-1	1.4-1	2.1-1
0	1.8-1	1.7-1
0	1.4-1	2.5-1

13. Bananito S.
2.5-1
2.5-1
2-1

14. San Clemente
2.6-1
1.1-1
4-1

15. Pandora
1.6-1
1.6-1
1-1

16. Fortuna
1-1
1-1
1.3-1

17. Aurora
1.6-1
1.3-1
1-1

18. Talia
1.2-1
1.3-1
1-1

19. Indiana I.
3-1
2-1
2-1

20. Indiana III.
10-1
6.7-1
6.5-1

21. Cristina
1-1
1-1
1-1

22. Barmouth W.
2-1
1-1
1-1

23. Zent (plot)
1-1
2-1
2-1

24. Chirripo
1-1
3-1
2-1

25. Alaska
3-1
3-1
1-1

26. Vesta
2-1
1-1
1-1

27. Venetia
5-1
1-1
1-1

28. Blanco
6-1
10-1
5-1

29. Parismina
.6-1
.3-1
.3-1

30. San Cecilio
1-1
1-1
1-1

31. Zent (cotton plot)
1-1
1-1
4-1

32. Livingston
1-1
1-1
1-1

33. Bristol (cotton plot)
1-1
1-1
1-1

34. Philadelphia S.
1–1
1–1
No MgO

35. San Andreas
.3–1
2–1
.2–1

36. Bananito N.
3–1
4–1
3–1

37. Colombiana
2–1
1–1
1–1

38. Salvador
1–1
.5–1
1–1

39. Bearesem W.
2–1
1–1
1–1

Ratio of Organic Matter to Nitrogen

A study of the ratio of organic matter to total nitrogen offers some interesting figures, which may throw light on the whole general subject of the relation of organic matter to general nutrition.

For good agricultural soils the nitrogen should be about .3 of the total organic matter as indicated by the loss on ignition. A ratio of organic matter to nitrogen from 30:1 to 40:1 may be regarded as normal and satisfactory. A study of the individual farms has given the figures which are tabulated below.

Ratio of Organic Matter (Loss on Ignition) to Nitrogen

30–1 to 40–1 regarded as normal

1. Walkyria	7. Carmen	13. Bananito S.
30–1	45–1	28–1
30–1	74–1	50–1
40–1	55–1	105–1
2. Precipicio	8. La Lola	14. San Clemente
61–1	45–1	30–1
69–1	60–1	53–1
100–1	82–1	67–1
3. Las Mercedes	9. Baltimore	15. Pandora
30–1	36–1	30–1
30–1	56–1	33–1
65–1	78–1	50–1
4. America	10. Bristol	16. Fortuna
60–1	36–1	42–1
220–1	50–1	54–1
1982–1	79–1	99–1
5. Louisiana	11. Luisa E.	17. Aurora
88–1	36–1	45–1
133–1	60–1	72–1
600–1	72–1	100–1
6. La Amelia	12. Philadelphia N.	18. Talia
36–1	60–1	40–1
45–1	48–1	46–1
40–1	84–1	73–1

19. Indiana I
350–1
93–1
188–1

20. Indiana III
45–1
63–1
64–1

21. Cristina
30–1
60–1
60–1

22. Barmouth W.
50–1
45–1
50–1

23. Zent (plot)
35–1
767–1
110–1

24. Chirripo
40–1
60–1
110–1

25. Alaska
46–1
50–1
16–1

26. Vesta
30–1
44–1
81–1

27. Venetia
36–1
75–1
78–1

28. Blanco
35–1
65–1
75–1

29. Parismina
32–1
35–1
150–1

30. San Cecilio
40–1
72–1
80–1

31. Zent (cotton plot)
56–1
60–1
100–1

32. Livingston
37–1
40–1
80–1

33. Bristol (cotton plot)
42–1
80–1
90–1

34. Philadelphia S.
54–1
63–1
112–1

35. San Andreas
80–1
72–1
60–1

36. Bananito N.
70–1
60–1
67–1

37. Colombiana
95–1
98–1
119–1

38. Salvador
45–1
33–1
45–1

39. Bearesem W. (mulched)
978–1
48–1
50–1

Ratio of Alumina to Potash

The Costa Rica Division is the only one in which separate analyses for alumina have been made. In general, alumina may be regarded as running from two to three times as high as the iron, although with high iron content, as is found in certain parts of this Division, this ratio is not fixed. The following table shows the ratios of alumina to potash. For good English soils a ratio of 10:1 is regarded as normal. No figures have been presented, so far as I am aware, for tropical soils. It will be noted that the figures show that the ratio of alumina to potash is considerably in excess of the English results.

Ratio of Alumina to Potash

English figures indicated 10–1 as normal

1. Walkyria
   38–1
   56–1
   48–1
2. Precipicio
   233–1
   320–1
   320–1
3. Las Mercedes
   54–1
   66–1
   50–1
4. America
   200–1
   225–1
   224–1
5. Louisiana
   200–1
   220–1
   30–1
6. La Amelia
   40–1
   25–1
   32–1
7. Carmen
   35–1
   24–1
   33–1
8. La Lola
   65–1
   80–1
   67–1
9. Baltimore
   53–1
   26–1
   34–1
10. Bristol
    43–1
    40–1
    32–1
11. Luisa E.
    25–1
    37–1
    25–1
12. Philadelphia N.
    20–1
    33–1
    30–1
13. Bananito S.
    20–1
    35–1
    33–1
14. San Clemente
    20–1
    48–1
    23–1
15. Pandora
    24–1
    20–1
    95–1
16. Fortuna
    18–1
    23–1
    23–1
17. Aurora
    20–1
    28–1
    8–1
18. Talia
    32–1
    41–1
    24–1
19. Indiana I
    40–1
    317–1
    500–1
20. Indiana III
    56–1
    24–1
    111–1
21. Cristina
    20–1
    35–1
    34–1
22. Barmouth W.
    30–1
    18–1
    24–1
23. Zent (plot)
    29–1
    33–1
    36–1
24. Chirripo
    25–1
    50–1
    43–1
25. Alaska
    33–1
    20–1
    20–1
26. Vesta
    25–1
    36–1
    24–1
27. Venetia
    46–1
    21–1
    24–1
28. Blanco
    21–1
    9–1
    10–1
29. Parismina
    35–1
    17–1
    100–1
30. San Cecilio
    24–1
    23–1
    30–1

31. Zent (cotton plot)
25–1
60–1
37–1

32. Livingston
42–1
11–1
18–1

33. Bristol (cotton plot)
30–1
14–1
23–1

34. Philadelphia S.
100–1
104–1
416–1

35. San Andreas
30–1
60–1
23–1

36. Bananito N.
31–1
40–1
35–1

37. Colombiana
180–1
165–1
180–1

38. Salvador
17–1
148–1
22–1

39. Bearesem W.
28–1
50–1
127–1

Examination of Individual Farms

Walkyria. A soil which should be satisfactory except for disease infection.

Precipicio. A very poor soil, physical properties objectionable, lacking in lime, although showing high organic matter.

Las Mercedes. A soil with excellent analysis, should be regarded as good.

America. A rather heavy soil, high in organic matter, but greatly lacking in lime.

Louisiana. A hard, heavy soil, high in organic matter, deficient in lime, very high in iron.

La Amelia. A good soil with well balanced analysis.

Carmen. A good soil, but slightly low in total nitrogen and high in iron.

La Lola. A soil of medium quality but so high in iron and low in phosphoric acid that it must be regarded as unsatisfactory.

Baltimore. A soil with very low water retaining sub-soil, high in iron, deficient in phosphoric acid.

Bristol. A light soil with good analysis. Rather high iron. Infection rather than soil quality responsible for its bad record in recent years.

Luisa East. A soil with good general qualities, but high in iron and low phosphoric acid.

Philadelphia North. A soil of objectionable physical qualities, deficient in phosphoric acid and nitrogen.

Bananito South. A good soil in spite of disease.

San Clemente. A hard, heavy soil which has been improved by mulching. The iron is too high and the phosphoric acid too low.

Pandora. A soil of rather undesirable physical qualities but rich in plant nutrients.

Fortuna. A rich soil.

Aurora. A rather thin soil very high in potash and rather low in nitrogen and phosphoric acid.

Talia. A good soil with well balanced analysis.

Indiana I. A worn-out soil markedly deficient in total nitrogen, potash and phosphoric acid.

Indiana III. A soil of excellent depth and good qualities.

Cristina. A soil of good depth, showing excellent analysis except for high iron.

Barmouth West. A soil of good depth and good analysis in which disease has probably been more responsible for poor production than chemical features.

Zent. A very heavily diseased area with good surface analysis, but deficient in lower layers in nitrogen and phosphoric acid.

Chirripo. A soil from which the humus layer has been washed away by flood; thin and contains an excess of iron. Deficient in nitrogen and phosphoric acid.

Alaska. A soil of good quality except for excess of iron.

Vesta. A soil of excellent surface analysis, but deficient in nitrogen in lower layers.

Venetia. A soil of fair physical properties, lacking in nitrogen and phosphoric acid and high in iron. Drainage also very poor.

Blanco. A light soil low in organic matter and nitrogen.

Parismina. The surface soil is rich, but the deeper layers are deficient in nitrogen, potash, lime and phosphoric acid; iron is high.

San Cecilio. A rather hard soil high in iron and low in phosphoric acid.

Zent (cotton plot). A light soil low in nitrogen.

Livingston. A thin, light soil with a very high iron content and the sub-surface layers deficient in nitrogen and phosphoric acid.

Bristol (cotton plot). Surface soil is excellent, deeper layers are low in nitrogen and phosphoric acid.

Philadelphia South. A soil of objectionable physical properties and very thin. The iron is very high; nitrogen, potash, phosphoric acid and lime all much below normal for the Division.

San Andreas. A light soil showing very low figures for nitrogen and phosphoric acid.

Bananito North. A soil of good depth and quality, but not rich.

Colombiana. Extremely high iron and hard and refractory in physical characters. These rather than lack of nutrients would seem to be responsible for poor production.

Salvador. A hard, heavy soil of good analysis.

Bearesem West. A soil of good depth, but low in total nitrogen.

Tabular View of Soil Conditions

Explanation of Abbreviations

Potash— h = greater than .30%
l = less than .15%
Lime— h = greater than 2%
l = less than 1%
Organic Matter—h = greater than 15%
l = less than 9%
Nitrogen— h = greater than .30%
l = less than .15%
Phosphoric Acid—h = greater than .30%
l = less than .15%

h = high m = medium r = rapid * = hard, refractory soil
l = low v = very s = slow

Farm	*History*	*Depth*	*Potash*	*Lime*	*Organic Matter*	*Nitrogen*	*Phosphoric Acid*	*Disease Spread*
Walkyria	poor	fair	m	l	l	ml	m	r
*Precipicio	very poor	good	l	vl	h	m	m	r
Las Mercedes	good	good	h	l	h	m	h	s
America	fair	good	l	vl	h	ml	h	r
*Louisiana	fair	good	m	vl	h	ml	h	s–r
Amelia	very good	good	h	m	m	m	h	m
Carmen	very good	deep	h	h	m	m	h	m
La Lola	fair	good	m	m	m	m	m	vr
Baltimore	poor	very thin	m	m	ml	m	l	r
Bristol	poor	very thin	h	m	m	m	m	s–r
Luisa E.	good	good	h	h	m	m	m	m
*Philadelphia N.	poor	fair	h	m	l	ml	l	m–r
Bananito S.	good	good	h	m	ml	m	m	s
San Clemente	good	fair	h	m	m	m	m	s

Pandora	very good	very good	h	m	m	h	m	s
Fortuna	excellent	good	h	h	m	m	m	s
Aurora	good	thin	h	h	ml	ml	m	r
Talia	none	good	h	h	m	m	m	r
Indiana I	fair	fair	l	m	m	vl	l	s–r
Indiana III	excellent	good	m	m	m	m	m	s
Cristina	fair	fair	m	l	h	h	h	s
Barmouth W.	fair	good	h	h	m	m	m	m–r
Zent	fair	fair	h	m	ml	l	m	s–r
Chirripo	good	very thin	m	h	l	l	m	s
Alaska	good	good	h	h	m	m	m	s
Vesta	good	fair	h	m	m	m	m	s
*Venetia	poor	fair	h	m	ml	m	m	m–r
Blanco	fair	fair	h	vh	l	ml	m	s–r
Parismina	good	good	h	l	h	h	h	r
San Cecilio	good	good	h	l	m	m	m	s
Zent	good	very thin	m	h	l	l	m	s
Livingston	good	thin	h	h	vl	l	l	s
Bristol	fair	good	h	m	m	ml	m	s
*Philadelphia S.	fair	good	l	l	m	ml	l	
San Andreas	poor	fair	m	m	m	l	l	r
Bananito N.	good	good	m	m	l	l	l	s
Colombiana	poor	good	m	l	h	m	m	
Salvador	poor	fair	m	l	h	h	m	
Bearesem W.	good	good	m	h	l	ml	m	s

From the foregoing tables it should be seen that the Costa Rica Division has but few really poor farms, considered from the standpoint of soil quality. The general infection with Panama disease tends to cause us to depreciate the value of these lands, which are in general rich, as tropical soils go. The Division is characterized by medium or high potash, rather low but generally satisfactory lime and lime-magnesia ratio, except in the Santa Clara District, a moderate but probably adequate total nitrogen, fairly good organic matter and phosphoric acid. There seems to be no actual deficiency in any of the plant nutrients, although possibly the availability of these may be low in some instances.

Mechanical Analysis. This Division has shown the most varied results in the mechanical analysis, giving a much higher percentage of gravel than in any other division. It also has the highest percentage of coarse sand, fine sand and clay, and the lowest percentage of silt. The latter plus the actual clay found by the method of classification used, gives what is sometimes termed "agricultural clay," the average amount of this combination being 48.7%. It will be noted from the table of average analyses that the farms showing the highest percentages of gravel are, in order, America, Las Mercedes, Luisa East, Cristina, Louisiana and Alaska, all of which exceed 20%. The lowest results were found in Carmen, Philadelphia North, Bananito South, San Andreas, Bearesem West, Indiana I and Indiana III, where no gravel was found. Another group, containing less than 1% of gravel, includes Amelia, Zent, Venetia, Bananito North, San Cecilio, Philadelphia South and San Clemente.

The highest percentages of silt were found, in order, in Bananito North, Chirripo, Carmen, Bananito South and Indiana III, all of which ran over

60%, while the lowest figures were obtained in America, Las Mercedes, Luisa East, Cristina and Louisiana, all of which ran below 25%.

The clay figures were largest in Alaska, Luisa East, Cristina, Vesta, Parismina, Fortuna and Barmouth West, while the lowest were in Livingston, Philadelphia South, Chirripo and Zent, all of which were below 4%.

The highest agricultural clays were in Bananito North, Carmen, Chirripo and Indiana III, and it is also notable that these farms show a fairly high percentage of lime.

Volatile Matter. The highest results in organic matter were found in Parismina, America, Louisiana, Colombiana, Las Mercedes and Cristina; the lowest in Livingston, Zent, Chirripo, Blanco, Bananito North, Philadelphia North and Bearesem West.

PANAMA DIVISION

The Panama Division, like the Costa Rica Division, is made up to a certain extent of decomposed basic lavas. The mechanical analysis shows the presence of fine gravel in five of the farms, four of them in Talamanca District. But every farm shows both coarse and fine sand as well as silt and clay. In this respect these analyses are in striking contrast to those of the Guatemala Division. As a result of this composition, the soils are almost all loose and light and fairly easily worked, although a few samples taken near the hills are harder and more refractory in character. Lime and magnesia are found in this Division in considerably greater amount than in the Guatemala Division and slightly greater amount than in Costa Rica. The ratios of these substances are, however, nearly the same as in Costa Rica, but the slightly higher percentage of lime is to be regarded favorably. As in Costa Rica, the Division shows a high percentage of iron. The percentage of phosphoric acid would under ordinary conditions be regarded as highly satisfactory, but in view of the high iron content it is probable that a portion of this phosphoric acid is so bound as to be unavailable for crop purposes. The percentage of volatile matter is good and the percentage of total nitrogen is somewhat below the normal relation which is expected in soils of temperate zones. As has been pointed out, however, these figures do not hold for the tropics. The detailed analyses are given in the following tables:

PANAMA DIVISION

SERIAL NUMBER *101*

Location: *Chase* Farm, Section ; *Line 35–38; 100 meters south of railroad.* Date: *October, 1916.* Collector: *H. D. A.*

Other distinguishing features: *Bananas very poor, heavy stand of grass.*

NATURAL FEATURES

Topography: *Bottom land.*
Drainage: *Good.*
Flood conditions: *Yearly.*
Silt deposition: *One to six inches yearly.*
Type of forest growth: *Heavy.*

CULTIVATION HISTORY

When cleared and planted: *1911.*
Number of replantings: *Supplying.* Why? *Previous wet condition.*
General condition when in production: *Fair.*
Plowed? *No.* When? Grubbed? *No.* When?
Years in bananas: *Five.* Life of farm: *Production increasing.*
Years in bush or fallow: *Never.*
Other crops grown: *None.*

DISEASE HISTORY

When first noted: *About 1915 in isolated cases.*
Age of plants when attacked: *About four years.*
Rapidity of spread: *Slow.*
Treatment given: *Digging out and burning and later bleaching.*

OTHER DATA

Colorado Disease present. Since 1916 has been treated by cleaning mats, mulching and replanting with healthy suckers, and farm shows general improvement.

	Surface—6"	6"—18"	18"—30"
Physical Examination			
Color	light brown	light brown	light brown
Compactness	hard	hard	very hard
Friability	refractory	refractory	refractory
Retentive power	39	72	64
Mechanical Examination			
Coarse gravel	0	0	0
Fine gravel	0	0	0
Coarse sand	14.0	10.8	0
Fine sand	20.6	16.4	40.6
Silt	61.1	68.8	52.4
Clay	4.3	4.0	7.0
Chemical Examination			
Organic matter	10.44	5.53	10.00
Total Nitrogen	.27	.12	.19
Potash (K_2O)	.47	.39	.81
Phosphoric acid (P_2O_5)	.40	.47	.61
Lime (CaO)	1.88	1.84	2.06
Magnesia (MgO)	.43	1.02	1.98
Iron (Fe_2O_3)	8.58	8.32	9.14
Alumina (Al_2O_3)			
Silica, sol. (SiO_2)			
Free Acidity			
Mycological Examination			
Typical Fusaria	Panama Disease present		
Other Fusaria	Colorado Disease present		

PANAMA DIVISION

SERIAL NUMBER *102*

Location: *Chase* Farm, Section *43; 50 meters west of line No. 60, 25 meters north of switch; about 10 feet lower level than sample 101.*

Date: *October, 1916.*
Collector: *H. D. A.*

Other distinguishing features: *Bananas heavy.*

NATURAL FEATURES

Topography: *Bottom land.*
Drainage: *Good.*
Flood conditions: *Every year.*
Silt deposition: *One to six inches.*
Type of forest growth: *Heavy.*

CULTIVATION HISTORY

When cleared and planted: *1911 by H. M. Feild.*
Number of replantings: *Supplying.* Why? *Previous wet condition.*
General condition when in production: *Fair.*
Plowed? *No.* When? Grubbed? *No.* When?
Years in bananas: *Five.* Life of farm: *Production improving.*
Years in bush or fallow: *Never.*
Other crops grown: *None.*

DISEASE HISTORY

When first noted: *About 1915.*
Age of plants when attacked: *About four.*
Rapidity of spread: *Slow.*
Treatment given: *Digging out, burning and bleaching.*

OTHER DATA

Colorado Disease present, same treatment as 101.

	Surface—6"	6"—18"	18"—30"
Physical Examination			
Color	light brown	light brown	light brown
Compactness	loose	loose	loose
Friability	light	light	light
Retentive power	83	77	60
Mechanical Examination			
Coarse gravel	0	0	0
Fine gravel	0	0	0
Coarse sand	0	0	37.0
Fine sand	16.4	24.6	26.2
Silt	75.3	68.4	31.6
Clay	8.3	7.0	5.2
Chemical Examination			
Organic matter	13.71	8.35	5.60
Total Nitrogen	.47	.01	.10
Potash (K_2O)	.34	.40	.12
Phosphoric acid (P_2O_5)	.61	.13	.52
Lime (CaO)	.59	.84	.71
Magnesia (MgO)	.62	1.20	1.23
Iron (Fe_2O_3)	6.40	7.68	6.90
Alumina (Al_2O_3)			
Silica, sol. (SiO_2)			
Free Acidity			
Mycological Examination			
Typical Fusaria	Panama Disease present		
Other Fusaria	Colorado Disease present		

PANAMA DIVISION

SERIAL NUMBER *103*

Location: *Paraiso* Farm, Section *38; 30 meters south of Anne farm line, 30 meters east of creek.*

Date: *October, 1916.*
Collector: *H. D. A.*

Other distinguishing features: *Bananas in poor condition; much grass.*

NATURAL FEATURES

Topography: *Bottom land.*
Drainage: *Natural and open ditches.*
Flood conditions: *Every few years.*
Silt deposition: *Several inches.*
Type of forest growth: *Heavy.*

CULTIVATION HISTORY

When cleared and planted: *1908–9.*
Number of replantings: *None.* Why? *Supplies only.*
General condition when in production: *Very good.*
Plowed? *No.* When? Grubbed? *No.* When?
Years in bananas: *Eight.* Life of farm: *Production still good.*
Years in bush or fallow: *Never.*
Other crops grown: *1916 reds and cacao planted.*

DISEASE HISTORY

When first noted: *1913.*
Age of plants when attacked: *Five years.*
Rapidity of spread: *Slow in 1913–14, more rapid since.*
Treatment given: *Digging out, burning and bleaching.*

OTHER DATA

Disease first appeared in scattered spots and along railroad. In 1916 some portions of section abandoned.

	Surface—6"	6"—18"	18"—30"
Physical Examination			
Color	light brown	light brown	light brown
Compactness	loose	loose	loose
Friability	light	light	light
Retentive power	83	61	73
Mechanical Examination			
Coarse gravel	0	0	0
Fine gravel	0	0	0
Coarse sand	22.8	24.4	26.7
Fine sand	29.5	29.6	26.6
Silt	41.6	41.0	41.7
Clay	6.1	5.0	5.0
Chemical Examination			
Organic matter	13.80	8.42	9.20
Total Nitrogen	.39	.14	.09
Potash (K_2O)	.51	.39	.39
Phosphoric acid (P_2O_5)	.15	.13	.15
Lime (CaO)	1.14	2.04	.96
Magnesia (MgO)	1.19	.68	.71
Iron (Fe_2O_3)	7.79	9.25	8.98
Alumina (Al_2O_3)			
Silica, sol. (SiO_2)			
Free Acidity			
Mycological Examination			
Typical Fusaria	Panama Disease present		
Other Fusaria	Colorado Disease present		

PANAMA DIVISION

Serial Number *104*

Location: *La Celia* Farm, Section *54*; *Near line of 54–56, 50 meters west of railroad.* Date: *October, 1916.* Collector: *H. D. A.*

Other distinguishing features: *Fine bananas.*

Natural Features

Topography: *Bottom land.*
Drainage: *Natural and open ditches.*
Flood conditions: *Every few years.*
Silt deposition: *Several inches.*
Type of forest growth: *Heavy.*

Cultivation History

When cleared and planted: *1904 by McConnell and abandoned.*
Number of replantings: *One in 1908.* Why?
General condition when in production: *Very good.*
Plowed? *No.* When? Grubbed? *No.* When?
Years in bananas: *Twelve.* Life of farm: *Very heavy production.*
Years in bush or fallow: *From 1904–8.*
Other crops grown: *1916 reds and cacao planted.*

Disease History

When first noted: *1907 before replanting.*
Age of plants when attacked: *Three years.*
Rapidity of spread: *Slow until 1913, since then rapid.*
Treatment given: *From 1912–15, digging out and burning; later bleaching.*

Other Data

Panama Disease is spreading along river and certain railroad frontage.

	Surface—6″	6″—18″	18″—30″
Physical Examination			
Color	light brown	light brown	light brown
Compactness	loose	loose	loose
Friability	light	light	light
Retentive power	59	46	65
Mechanical Examination			
Coarse gravel	0	0	0
Fine gravel	0	0	0
Coarse sand	15.2	9.6	10.8
Fine sand	18.6	17.2	18.8
Silt	62.4	67.8	65.7
Clay	3.8	5.4	4.7
Chemical Examination			
Organic matter	6.57	6.75	3.88
Total Nitrogen	.12	.07	.14
Potash (K_2O)	.08	.55	.16
Phosphoric acid (P_2O_5)	.33	.25	.26
Lime (CaO)	2.38	2.74	1.94
Magnesia (MgO)	1.70	2.11	.23
Iron (Fe_2O_3)			
Alumina (Al_2O_3)			
Silica, sol. (SiO_2)			
Free Acidity			
Mycological Examination			
Typical Fusaria	Panama Disease present		
Other Fusaria	Very little Colorado Disease		

PANAMA DIVISION

SERIAL NUMBER *105*

Location: *Isla Grande* Farm, Section *24; 30 meters east of line 20 and 100 meters north of main line.*

Date: *October, 1916.*
Collector: *H. D. A.*

Other distinguishing features:

NATURAL-FEATURES

Topography: *Bottom land.*
Drainage: *Natural with a few open ditches.*
Flood conditions: *About once every two years.*
Silt deposition: *From one inch to a foot.*
Type of forest growth: *Heavy.*

CULTIVATION HISTORY

When cleared and planted: *1904 but abandoned until 1909.*
Number of replantings: *One.* Why? *1909–10 after U. F. Co. took over.*
General condition when in production: *Good since 1910.*
Plowed? *No.* When? Grubbed? *No.* When?
Years in bananas: *Twelve.* Life of farm: *Good producer.*
Years in bush or fallow: *Abandoned from 1904–9.*
Other crops grown: *A few Congos.*

DISEASE HISTORY

When first noted: *1906 or earlier.*
Age of plants when attacked: *About two years.*
Rapidity of spread: *Slow, mostly along river and railroad.*
Treatment given: *Digging out, burning and bleaching.*

OTHER DATA

Area has produced fine bananas, now badly diseased.

	Surface—6"	6"—18"	18"—30"
Physical Examination			
Color	light brown	light brown	light brown
Compactness	loose	loose	loose
Friability	light	light	light
Retentive power	56	49	49
Mechanical Examination			
Coarse gravel	0	0	0
Fine gravel	0	0	0
Coarse sand	13.5	5.4	6.0
Fine sand	18.7	7.5	14.0
Silt	63.7	82.2	75.0
Clay	4.1	4.9	5.0
Chemical Examination			
Organic matter	6.10	5.32	6.80
Total Nitrogen	.12	.09	.14
Potash (K_2O)	.34	.53	.46
Phosphoric acid (P_2O_5)	.28	.26	.11
Lime (CaO)	2.08	2.07	1.87
Magnesia (MgO)	.60	1.19	.57
Iron (Fe_2O_3)	8.40	9.81	6.28
Alumina (Al_2O_3)			
Silica, sol. (SiO_2)			
Free Acidity			
Mycological Examination			
Typical Fusaria	Panama Disease present		
Other Fusaria	Very little Colorado Disease		

PANAMA DIVISION

SERIAL NUMBER *106*

Location: *La Celia* Farm, Section *30; 50 meters west of Favorita Camps, 50 meters north of river line.*

Date: *October, 1916.*
Collector: *H. D. A.*

Other distinguishing features: *Heavy covering of grass.*

NATURAL FEATURES

Topography: *Bottom land.*
Drainage: *Natural and artificial.*
Flood conditions: *Every few years.*
Silt deposition: *Several inches.*
Type of forest growth: *Heavy.*

CULTIVATION HISTORY

When cleared and planted: *1904 and abandoned until 1908.*
Number of replantings: *1908.* Why?
General condition when in production: *Very good.*
Plowed? *No.* When? Grubbed? *No.* When?
Years in bananas: *Twelve.* Life of farm: *Very heavy producer.*
Years in bush or fallow: *From 1904–8.*
Other crops grown: *1916 reds and cacao.*

DISEASE HISTORY

When first noted: *In spots on riverbank in 1907.*
Age of plants when attacked: *About three years.*
Rapidity of spread: *Slow until 1913, then rapid along river and railroad.*
Treatment given: *From 1912–15, digging out and burning; later bleaching.*

OTHER DATA

	Surface—6"	6"—18"	18"—30"
Physical Examination			
Color	light brown	light brown	light brown
Compactness	loose	loose	loose
Friability	light	light	light
Retentive power	81	65	48
Mechanical Examination			
Coarse gravel	0	0	0
Fine gravel	0	0	0
Coarse sand	20.6	10.6	5.2
Fine sand	32.8	42.0	69.8
Silt	41.5	43.0	21.9
Clay	5.1	4.4	3.1
Chemical Examination			
Organic matter	9.88	5.82	6.18
Total Nitrogen	.27	.13	.08
Potash (K_2O)	.44	.21	.18
Phosphoric acid (P_2O_5)	.06	.28	.20
Lime (CaO)	2.27	2.19	1.45
Magnesia (MgO)	1.59	.91	1.62
Iron (Fe_2O_3)	8.84	9.14	9.59
Alumina (Al_2O_3)			
Silica, sol. (SiO_2)			
Free Acidity			
Mycological Examination			
Typical Fusaria	Panama Disease present		
Other Fusaria	Colorado Disease present		

PANAMA DIVISION

SERIAL NUMBER *107*

Location: *Daytonia* Farm, Section *61; Center of old Zavala house spot.* Date: *October, 1916.*

Other distinguishing features: *Area had been planted in bananas with poor results.* Collector: *H. D. A.*

NATURAL FEATURES

Topography: *Bottom land.*
Drainage: *Artificial toward swamps.*
Flood conditions: *Only in case of very heavy floods.*
Silt deposition: *None.*
Type of forest growth: *Heavy.*

CULTIVATION HISTORY

When cleared and planted: *1909-10.*
Number of replantings: *1911.* Why? *Due to drainage.*
General condition when in production: *Very good since 1911.*
Plowed? *No.* When? Grubbed? *No.* When?
Years in bananas. *Six.* Life of farm: *Production good.*
Years in bush or fallow: *Never.*
Other crops grown: *1916 reds and cacao.*

DISEASE HISTORY

When first noted: *1913 in spots.*
Age of plants when attacked: *Two years.*
Rapidity of spread: *Slow.*
Treatment given: *From 1913–15, digging out and burning; later bleaching.*

OTHER DATA

	Surface—6″	6″—18″	18″—30″
PHYSICAL EXAMINATION			
Color	light brown	light brown	light brown
Compactness	loose	loose	loose
Friability	light	light	light
Retentive power	76	67	58
MECHANICAL EXAMINATION			
Coarse gravel	0	0	0
Fine gravel	0	0	0
Coarse sand	18.4	0	28.8
Fine sand	28.2	0	26.2
Silt	48.7	95.8	38.8
Clay	4.7	4.2	6.2
CHEMICAL EXAMINATION			
Organic matter	10.37	7.20	7.21
Total Nitrogen	.27	.15	.14
Potash (K_2O)	.55	.41	.57
Phosphoric acid (P_2O_5)	.23	.30	.25
Lime (CaO)	2.23	1.77	1.71
Magnesia (MgO)	2.15	.67	1.55
Iron (Fe_2O_3)	7.76	8.63	8.45
Alumina (Al_2O_3)			
Silica, sol. (SiO_2)			
Free Acidity			
MYCOLOGICAL EXAMINATION			
Typical Fusaria	Panama Disease present		
Other Fusaria	Very little Colorado Disease		

PANAMA DIVISION

SERIAL NUMBER *108*

Location: *Costa Rica* Farm, Section *14; 30 meters north of river bank.* Date: *October, 1916.*

Other distinguishing features: *Area has always given poor results.* Collector: *H. D. A.*

NATURAL FEATURES

Topography: *Bottom land.*
Drainage: *Natural and artificial.*
Flood conditions: *Seldom flooded.*
Silt deposition: *None.*
Type of forest growth: *Heavy.*

CULTIVATION HISTORY

When cleared and planted: *1904, but abandoned until 1907.*
Number of replantings: *1907.* Why? *Taken over by U. F. Co.*
General condition when in production: *From 1909–14 good, then disease increased.*
Plowed? *No.* When? Grubbed? *No.* When?
Years in bananas: *Twelve.* Life of farm: *One-third abandoned, rest diseased.*
Years in bush or fallow: *From 1904–7.*
Other crops grown: *Congos and Chinese; 1916 reds and cacao.*

DISEASE HISTORY

When first noted: *1906 on river frontage.*
Age of plants when attacked: *Two.*
Rapidity of spread: *Slow until 1914, then rapid to date.*
Treatment given: *From 1908–14, digging out and burning; later bleaching.*

OTHER DATA

	Surface—6"	6"—18"	18"—30"
Physical Examination			
Color	light brown	light brown	light brown
Compactness	loose	loose	loose
Friability	light	light	light
Retentive power	89	66	76
Mechanical Examination			
Coarse sand	0	0	0
Fine gravel	0	0	0
Coarse sand	7.4	11.2	32.8
Fine sand	32.6	32.0	29.5
Silt	53.9	51.4	31.7
Clay	6.1	5.4	6.0
Chemical Examination			
Organic matter	15.05	8.17	7.65
Total Nitrogen	.45	.12	.12
Potash (K_2O)	.41	.26	.34
Phosphoric acid (P_2O_5)	.45	.16	.27
Lime (CaO)	1.68	1.50	1.28
Magnesia (MgO)	1.60	.19	.79
Iron (Fe_2O_3)	8.23	9.96	10.21
Alumina (Al_2O_3)			
Silica, sol. (SiO_2)			
Free Acidity			
Mycological Examination			
Typical Fusaria	Panama Disease present		
Other Fusaria			

PANAMA DIVISION

SERIAL NUMBER *109*

Location: *Costa Rica* Farm, Section *15*. Date: *October, 1916.*
Other distinguishing features: *Near line of 15–18. Heavy stand.* Collector: *H. D. A.*

NATURAL FEATURES

Topography: *Bottom land.*
Drainage: *Natural and open ditches.*
Flood conditions: *Yearly.*
Silt deposition: *An inch or more a year.*
Type of forest growth: *Heavy.*

CULTIVATION HISTORY

When cleared and planted: *1904 and abandoned until 1908.*
Number of replantings: *One, 1907–8.* Why? *Drainage operations.*
General condition when in production: *Very good from 1909–14, now decreasing.*
Plowed? *No.* When? Grubbed? *No.* When?
Years in bananas: *Twelve.* Life of farm: *Disease has taken about one-third of farm, and is scattered through the rest.*
Years in bush or fallow:
Other crops grown: *A few Congos and Chinese; 1916, reds and cacao.*

DISEASE HISTORY

When first noted: *1906 on river front.*
Age of plants when attacked: *Two years.*
Rapidity of spread: *Very rapid and now scattered throughout.*
Treatment given: *From 1908–14, digging out and burning. 1914, diseased land was quarantined and abandoned. Later, some bleach has been used.*

OTHER DATA

	Surface—6"	6"—18"	18"—30"
Physical Examination			
Color	light brown	light brown	light brown
Compactness	loose	loose	loose
Friability	light	light	light
Retentive power	42	58	59
Mechanical Examination			
Coarse gravel	0	0	0
Fine gravel	0	0	0
Coarse sand	5.9	15.7	0
Fine sand	39.9	21.5	0
Silt	50.2	57.3	94.8
Clay	4.0	5.5	5.2
Chemical Examination			
Organic matter	8.07	5.99	9.00
Total Nitrogen	.14	.13	.01
Potash (K_2O)	.46	.60	.17
Phosphoric acid (P_2O_5)	.28	.39	.54
Lime (CaO)	1.71	1.94	2.51
Magnesia (MgO)	.78	1.92	1.79
Iron (Fe_2O_3)	7.96	9.61	10.21
Alumina (Al_2O_3)			
Silica, sol. (SiO_2)			
Free Acidity			
Mycological Examination			
Typical Fusaria	Panama Disease present		
Other Fusaria			

PANAMA DIVISION

SERIAL NUMBER *110*

Location: *José* Farm, Section *13; 50 meters east of railroad.* Date: *October, 1916.*
Other distinguishing features: Collector: *H. D. A.*

NATURAL FEATURES

Topography: *Valley.*
Drainage: *Heavy artificial from hills to swamp.*
Flood conditions: *Frequent and heavy.*
Silt deposition: *From one inch upwards.*
Type of forest growth: *Heavy.*

CULTIVATION HISTORY

When cleared and planted: *1907–8.*
Number of replantings: *1909, 1912.* Why? *Due to drainage and to hurricane.*
General condition when in production: *Good until hurricane of 1912.*
Plowed? *No.* When? Grubbed? *No.* When?
Years in bananas: *Nine.* Life of farm: *Practically abandoned.*
Years in bush or fallow: *Two.*
Other crops grown: *A few Congos and Chinese.*

DISEASE HISTORY

When first noted: *1910.*
Age of plants when attacked: *Two years.*
Rapidity of spread: *Dug up and burned from 1909–12, very rapid after 1913.*
Treatment given: *Digging out and burning.*

OTHER DATA

This area was the first to become diseased in San San, and was abandoned about two years before the sample was taken.

	Surface—6"	6"—18"	18"—30"
Physical Examination			
Color	light brown	light brown	light brown
Compactness	hard	hard	hard
Friability	heavy	heavy	heavy
Retentive power	88	63	63
Mechanical Examination			
Coarse gravel	0	0	0
Fine gravel	0.4	0	0
Coarse sand	34.0	30.8	0
Fine sand	30.0	29.2	32.5
Silt	27.8	34.9	60.8
Clay	7.8	5.1	6.7
Chemical Examination			
Organic matter	18.40	9.42	10.40
Total Nitrogen	.59	.14	.13
Potash (K_2O)	.32	.37	.67
Phosphoric acid (P_2O_5)	.34	.24	.10
Lime (CaO)	2.24	1.86	1.48
Magnesia (MgO)	1.70	.89	.31
Iron (Fe_2O_3)	8.41	9.97	10.49
Alumina (Al_2O_3)			
Silica, sol. (SiO_2)			
Free Acidity			
Mycological Examination			
Typical Fusaria	Panama Disease present		
Other Fusaria			

PANAMA DIVISION

SERIAL NUMBER *111*

Location: *Drury* Farm, Section *61; 40 meters south of main line, 10 meters west of switch.*

Date: *October, 1916.*
Collector: *H. D. A.*

Other distinguishing features:

NATURAL FEATURES
Topography: *Valley.*
Drainage: *Heavy artificial, large ditches.*
Flood conditions: *Frequent and heavy.*
Silt deposition: *One inch up per year.*
Type of forest growth: *Heavy.*

CULTIVATION HISTORY
When cleared and planted: *1908–9.*
Number of replantings: *1910, 1912.* Why? *Drainage, and hurricane.*
General condition when in production: *Production heavy until hurricane of 1912.*
Plowed? *No.* When? Grubbed? *No.* When?
Years in bananas: *Eight.* Life of farm: *Largely abandoned.*
Years in bush or fallow: *Large part since 1915.*
Other crops grown: *Few Congos and Chinese.*

DISEASE HISTORY
When first noted: *Almost from the start in 1908.*
Age of plants when attacked: *A few months.*
Rapidity of spread: *Slow until hurricane of 1912, then rapid.*
Treatment given: *Digging out and burning.*

OTHER DATA
This area was one of the first planted in San San and the bananas are still quite healthy.

	Surface—6"	6"—18"	18"—30"
Physical Examination			
Color	light brown	light brown	light brown
Compactness	loose	loose	loose
Friability	light	light	light
Retentive power	84	83	72
Mechanical Examination			
Coarse gravel	0	0	0
Fine gravel	0	0	0
Coarse sand	0	33.9	35.1
Fine sand	29.6	31.3	31.3
Silt	62.7	27.4	26.2
Clay	7.7	7.4	7.4
Chemical Examination			
Organic matter	16.61	12.00	10.82
Total Nitrogen	.16	.27	.18
Potash (K_2O)	.34	.21	.35
Phosphoric acid (P_2O_5)	.27	.19	.21
Lime (CaO)	1.31	1.36	1.63
Magnesia (MgO)	1.23	1.10	1.29
Iron (Fe_2O_3)	10.09	11.31	11.83
Alumina (Al_2O_3)			
Silica, sol. (SiO_2)			
Free Acidity			
Mycological Examination			
Typical Fusaria	Panama Disease present		
Other Fusaria			

PANAMA DIVISION

Serial Number *112*

Location: *Margarita* Farm, Section *9; 50 meters north of line 8–9.* Date: *October, 1916.*

Other distinguishing features: *Fine bananas.* Collector: *H. D. A.*

Natural Features

Topography: *Bottom land.*
Drainage: *Natural to river.*
Flood conditions: *About every two years.*
Silt deposition: *From one inch to a foot.*
Type of forest growth: *Heavy.*

Cultivation History

When cleared and planted: *1909.*
Number of replantings: *None.* Why?
General condition when in production: *Excellent to date.*
Plowed? *No.* When? Grubbed? *No.* When?
Years in bananas: *Seven.* Life of farm: *Excellent condition.*
Years in bush or fallow: *Never.*
Other crops grown: *1916, reds and cacao planted in diseased spots.*

Disease History

When first noted: *In spots on river and railroad in 1911.*
Age of plants when attacked: *Two years.*
Rapidity of spread: *Slow in 1911–14, in 1915–16 rapid in some spots.*
Treatment given: *Digging out, burning and bleaching.*

Other Data

Colorado Disease is also present and has been cleaned out and healthy suckers planted.

	Surface—6"	6"—18"	18"—30"
Physical Examination			
Color	light brown	light brown	light brown
Compactness	loose	loose	loose
Friability	light	light	light
Retentive power	57	51	41
Mechanical Examination			
Coarse gravel	0	0	0
Fine gravel	0	0	0
Coarse sand	0	11.4	0
Fine sand	0	30.9	21.0
Silt	96.0	53.8	75.9
Clay	4.0	3.9	3.1
Chemical Examination			
Organic matter	8.50	5.36	5.36
Total Nitrogen	.16	.12	.07
Potash (K_2O)	.51	.40	.62
Phosphoric acid (P_2O_5)	.22	.41	.11
Lime (CaO)	2.02	2.12	2.30
Magnesia (MgO)	.76	1.87	1.36
Iron (Fe_2O_3)	9.61	7.89	10.17
Alumina (Al_2O_3)			
Silica, sol. (SiO_2)			
Free Acidity			
Mycological Examination			
Typical Fusaria	Panama Disease present		
Other Fusaria	Colorado Disease present		

PANAMA DIVISION

SERIAL NUMBER *113*

Location: *Margarita* Farm, Section *8; 100 meters from 112.* Date: *October, 1916.*
Other distinguishing features: *Spot abandoned due to Panama Disease.* Collector: *H. D. A.*

NATURAL FEATURES

Topography: *Bottom land.*
Drainage: *Natural to river.*
Flood conditions: *About every two years.*
Silt deposition: *From one inch to a foot.*
Type of forest growth: *Heavy.*

CULTIVATION HISTORY

When cleared and planted: *1909.*
Number of replantings: *None.* Why?
General condition when in production: *Excellent to date.*
Plowed? *No.* When? Grubbed? *No.* When?
Years in bananas: *Seven.* Life of farm: *Excellent condition.*
Years in bush or fallow: *Never.*
Other crops grown: *1916, reds and cacao in disease spots.*

DISEASE HISTORY

When first noted: *In spots on river and railroad in 1911.*
Age of plants when attacked: *Two years.*
Rapidity of spread: *Slow to 1915, rapid in spots since.*
Treatment given: *Digging out, burning and bleaching.*

OTHER DATA

	Surface—6"	6"—18"	18"—30"
PHYSICAL EXAMINATION			
Color	light brown	light brown	light brown
Compactness	loose	loose	loose
Friability	light	light	light
Retentive power	61	41	64
MECHANICAL EXAMINATION			
Coarse gravel	0	0	0
Fine gravel	0	0	0
Coarse sand	0	2.9	19.3
Fine sand	5.0	13.0	27.5
Silt	91.1	80.1	49.9
Clay	3.9	4.0	3.3
CHEMICAL EXAMINATION			
Organic matter	8.12	4.93	6.75
Total Nitrogen	.17	.07	.14
Potash (K_2O)	.23	.21	.27
Phosphoric acid (P_2O_5)	.29	.11	.14
Lime (CaO)	1.63	2.26	2.36
Magnesia (MgO)	.27	1.32	.82
Iron (Fe_2O_3)	9.14	5.96	9.43
Alumina (Al_2O_3)			
Silica, sol. (SiO_2)			
Free Acidity			
MYCOLOGICAL EXAMINATION			
Typical Fusaria	**Panama Disease very bad in this spot**		
Other Fusaria	Colorado Disease present in farm		

PANAMA DIVISION

Serial Number *114*

Location: *Catarina* Farm, Section *39; Opposite junction of old river line with main.* Date: *October, 1916.* Collector: *H. D. A.*

Other distinguishing features: *Has produced much good fruit, now diseased.*

Natural Features

Topography: *Bottom land.*
Drainage: *Natural toward river.*
Flood conditions: *About once in two years.*
Silt deposition: *From one inch to a foot.*
Type of forest growth: *Heavy.*

Cultivation History

When cleared and planted: *1909.*
Number of replantings: *None.* Why?
General condition when in production: *Good.*
Plowed? *No.* When? Grubbed? *No.* When?
Years in bananas: *Seven.* Life of farm: *Production still excellent.*
Years in bush or fallow: *Never.*
Other crops grown: *None.*

Disease History

When first noted: *1911, along river and railroad.*
Age of plants when attacked: *Two years.*
Rapidity of spread: *Slow until 1915, then rapid in spots.*
Treatment given: *Digging out, burning and later bleaching.*

Other Data

	Surface—6"	6"—18"	18"—30"
Physical Examination			
Color	light brown	light brown	light brown
Compactness	loose	loose	loose
Friability	light	light	light
Retentive power	75	68	49
Mechanical Examination			
Coarse gravel	0	0	0
Fine gravel	0	0	0
Coarse sand	13.5	16.8	11.0
Fine sand	24.9	25.6	17.3
Silt	56.0	52.6	67.5
Clay	5.6	5.0	4.2
Chemical Examination			
Organic matter	13.49	7.77	6.21
Total Nitrogen	.33	.18	.09
Potash (K_2O)	.40	.35	.50
Phosphoric acid (P_2O_5)	.46	.30	.27
Lime (CaO)	2.28	3.00	1.92
Magnesia (MgO)	1.69	.82	.65
Iron (Fe_2O_3)	8.23	9.12	7.96
Alumina (Al_2O_3)			
Silica, sol. (SiO_2)			
Free Acidity			
Mycological Examination			
Typical Fusaria	Panama Disease present		
Other Fusaria	Colorado Disease present		

PANAMA DIVISION

SERIAL NUMBER *115*

Location: *Nievecito* Farm, Section *51; 30 meters south of line 37, opposite junction of lines 37 and 43.*

Date: *October, 1916.*
Collector: *H. D. A.*

Other distinguishing features:

NATURAL FEATURES

Topography: *Bottom land.*
Drainage: *Natural and artificial.*
Flood conditions: *Every two or three years.*
Silt deposition: *Several inches in floods.*
Type of forest growth: *Heavy.*

CULTIVATION HISTORY

When cleared and planted: *1916 (area sampled).*
Number of replantings: *None.* Why?
General condition when in production: *Only about five months old.*
Plowed? *No.* When? Grubbed? *No.* When?
Years in bananas: *5 months.* Life of farm: *Rest of farm badly diseased.*
Years in bush or fallow: *Never.*
Other crops grown: *None.*

DISEASE HISTORY

When first noted: *Plant near sample diseased.*
Age of plants when attacked: *Four or five months.*
Rapidity of spread: *Rapid in other parts of farm.*
Treatment given: *Digging out and burning; bleaching in other parts of farm.*

OTHER DATA

	Surface—6"	6"—18"	18"—30"
Physical Examination			
Color	light brown	light brown	light brown
Compactness	loose	loose	loose
Friability	light	light	light
Retentive power	79	67	67
Mechanical Examination			
Coarse gravel	0	0	0
Fine gravel	0	0	0
Coarse sand	0	31.9	0
Fine sand	0	31.6	0.5
Silt	94.2	30.3	93.7
Clay	5.8	6.2	5.8
Chemical Examination			
Organic matter	13.20	9.70	9.47
Total Nitrogen	.03	.13	.01
Potash (K_2O)	.34	.14	.36
Phosphoric acid (P_2O_5)	.38	.22	.20
Lime (CaO)	.88	.95	1.05
Magnesia (MgO)	.82	.18	.86
Iron (Fe_2O_3)	9.54	9.40	11.06
Alumina (Al_2O_3)			
Silica, sol. (SiO_2)			
Free Acidity			
Mycological Examination			
Typical Fusaria	Panama Disease present		
Other Fusaria	Colorado Disease also present in farm		

PANAMA DIVISION

SERIAL NUMBER *116*

Location: *Riverside* Farm, Section *21–34; 40 meters south of main railroad.*

Date: *October, 1916.*
Collector: *H. D. A.*

Other distinguishing features:

NATURAL FEATURES

Topography: *Bottom land.*
Drainage: *Natural and artificial.*
Flood conditions: *Every two or three years.*
Silt deposition: *From one inch up.*
Type of forest growth: *Heavy.*

CULTIVATION HISTORY

When cleared and planted: *1904 and abandoned until 1908.*
Number of replantings: *One in 1908.* Why? *Taken over by U. F. Co.*
General condition when in production: *Very good.*
Plowed? *No.* When? Grubbed? *No.* When?
Years in bananas: *Twelve.* Life of farm: *Still good.*
Years in bush or fallow: *Never.*
Other crops grown: *A few Congos and later reds.*

DISEASE HISTORY

When first noted: *1908 in spots only.*
Age of plants when attacked: *Two years.*
Rapidity of spread: *Slow until 1914, later rapid in spots.*
Treatment given: *Digging out, burning and bleaching.*

OTHER DATA

	Surface—6"	6"—18"	18"—30"
Physical Examination			
Color	light brown	light brown	light brown
Compactness	loose	loose	loose
Friability	light	light	light
Retentive power	60	58	55
Mechanical Examination			
Coarse gravel	0	0	0
Fine gravel	0	0	0
Coarse sand	12.5	12.4	17.7
Fine sand	18.6	14.6	77.6
Silt	64.8	69.4	4.7
Clay	4.1	3.6	
Chemical Examination			
Organic matter	6.22	6.33	7.76
Total Nitrogen	.14	.09	.12
Potash (K_2O)	.59	.58	.49
Phosphoric acid (P_2O_5)	.03	.08	.14
Lime (CaO)	1.96	1.92	2.86
Magnesia (MgO)	1.96	2.12	2.30
Iron (Fe_2O_3)	8.10	8.01	8.94
Alumina (Al_2O_3)			
Silica, sol. (SiO_2)			
Free Acidity			
Mycological Examination			
Typical Fusaria	Panama Disease present		
Other Fusaria	Colorado Disease present		

PANAMA DIVISION

SERIAL NUMBER *117*

Location: *Riverside* Farm, Section *7; 30 meters from Barranca line and 150 meters south of line 37.*

Date: *October, 1916.*
Collector: *H. D. A.*

Other distinguishing features:

NATURAL FEATURES
Topography: *Bottom land.*
Drainage: *Natural and artificial.*
Flood conditions: *Every two or three years.*
Silt deposition: *From one inch up.*
Type of forest growth: *Heavy.*

CULTIVATION HISTORY
When cleared and planted: *1916 (part where sample was taken).*
Number of replantings: *None.* Why?
General condition when in production: *Rest of farm very good.*
Plowed? *No.* When? Grubbed? *No.* When?
Years in bananas: *A few months.* Life of farm:
Years in bush or fallow: *Never.*
Other crops grown: *None.*

DISEASE HISTORY
When first noted: *Not in newly planted area.*
Age of plants when attacked:
Rapidity of spread:
Treatment given:

OTHER DATA
Sample taken in newly planted area.

	Surface—6"	6"—18"	18"—30"
Physical Examination			
Color	light brown	light brown	light brown
Compactness	loose	loose	loose
Friability	light	light	light
Retentive power	92	77	70
Mechanical Examination			
Coarse gravel	0	0	0
Fine gravel	0	0	0
Coarse sand	35.4	37.2	37.1
Fine sand	31.6	29.3	31.7
Silt	25.6	25.7	24.2
Clay	7.4	7.8	7.0
Chemical Examination			
Organic matter	11.32	10.70	9.28
Total Nitrogen	.32	.01	.14
Potash (K_2O)	.29	.26	.61
Phosphoric acid (P_2O_5)	.27	.31	.23
Lime (CaO)	2.26	1.27	1.65
Magnesia (MgO)	.57	.93	.75
Iron (Fe_2O_3)	9.70	9.23	10.60
Alumina (Al_2O_3)			
Silica, sol. (SiO_2)			
Free Acidity			
Mycological Examination			
Typical Fusaria	Panama Disease in old part of farm		
Other Fusaria	Colorado Disease in old part of farm		

PANAMA DIVISION

SERIAL NUMBER *118*

Location: *Barranca* Farm, Section *10; 20 meters south line 39, 30 meters east of section line 10–11.*

Date: *October, 1916.*
Collector: *H. D. A.*

Other distinguishing features:

NATURAL FEATURES
- Topography: *Bottom land.*
- Drainage: *Natural and artificial.*
- Flood conditions: *Once in two years.*
- Silt deposition: *Inch or more in floods.*
- Type of forest growth: *Heavy.*

CULTIVATION HISTORY
- When cleared and planted: *1904 and abandoned until 1908.*
- Number of replantings: *By supplies.* Why?
- General condition when in production: *Very good.*
- Plowed? *No.* When? Grubbed? *No.* When?
- Years in bananas: *Sixteen.* Life of farm: *Still good producer.*
- Years in bush or fallow: *Never.*
- Other crops grown: *Congos, and later reds and cacao.*

DISEASE HISTORY
- When first noted: *1908, in spots along river and railroad.*
- Age of plants when attacked: *Four years.*
- Rapidity of spread: *Slow until 1916, now more rapid.*
- Treatment given: *Digging out, burning and bleaching.*

OTHER DATA

Area badly diseased, was once used as a place for dumping banana trash.

	Surface—6"	6"—18"	18"—30"
Physical Examination			
Color	light brown	light brown	light brown
Compactness	loose	loose	loose
Friability	light	light	light
Retentive power	71	72	74
Mechanical Examination			
Coarse gravel	0	0	0
Fine gravel	0	0	0
Coarse sand	20.7	25.2	35.1
Fine sand	31.8	29.2	28.3
Silt	41.6	38.5	29.6
Clay	5.9	7.1	7.0
Chemical Examination			
Organic matter	10.16	10.22	9.30
Total Nitrogen	.23	.25	.19
Potash (K_2O)	.33	.09	.33
Phosphoric acid (P_2O_5)	.32	.32	.32
Lime (CaO)	1.51	1.62	1.74
Magnesia (MgO)	.44	.17	1.59
Iron (Fe_2O_3)	8.36	11.21	6.70
Alumina (Al_2O_3)			
Silica, sol. (SiO_2)			
Free Acidity			
Mycological Examination			
Typical Fusaria	Panama Disease present		
Other Fusaria	Colorado Disease present		

PANAMA DIVISION

SERIAL NUMBER *119*

Location: *Elena* Farm, Section *30; 10 meters south of line 49, opposite section line 29–30.*

Date: *October, 1916.*
Collector: *H. D. A.*

Other distinguishing features:

NATURAL FEATURES

Topography: *Bottom land.*
Drainage: *Natural and artificial.*
Flood conditions: *About once a year.*
Silt deposition: *Heavy during floods.*
Type of forest growth: *Heavy.*

CULTIVATION HISTORY

When cleared and planted: *1906–7 by negro squatters; finished by U. F. Co. 1911.*
Number of replantings: *One, 1912.* Why? *Hurricane.*
General condition when in production: *Since 1911 very good.*
Plowed? *No.* When? Grubbed? *No.* When?
Years in bananas: *Ten.* Life of farm: *Very good production.*
Years in bush or fallow: *Never.*
Other crops grown: *1916, reds and cacao.*

DISEASE HISTORY

When first noted: *Soon after planting.*
Age of plants when attacked: *About a year.*
Rapidity of spread: *Slow until 1915, later rapid in spots.*
Treatment given: *Digging out, burning and bleaching.*

OTHER DATA

Area produced fine bananas but later destroyed by disease. Reds planted in spot now show disease.

	Surface—6"	6"—18"	18"—30"
PHYSICAL EXAMINATION			
Color	light brown	light brown	light brown
Compactness	loose	loose	loose
Friability	light	light	light
Retentive power	57	47	41
MECHANICAL EXAMINATION			
Coarse gravel	0	0	0
Fine gravel	0	0	0
Coarse sand	11.8	11.9	2.1
Fine sand	22.6	16.9	34.5
Silt	62.1	68.2	59.9
Clay	3.5	3.0	3.5
CHEMICAL EXAMINATION			
Organic matter	7.23	5.43	5.34
Total Nitrogen	.14	.11	.11
Potash (K_2O)	.40	.24	.10
Phosphoric acid (P_2O_5)	.29	.25	.27
Lime (CaO)	2.43	1.76	.19
Magnesia (MgO)	1.70	1.78	.25
Iron (Fe_2O_3)	9.26	8.55	6.97
Alumina (Al_2O_3)			
Silica, sol. (SiO_2)			
Free Acidity			
MYCOLOGICAL EXAMINATION			
Typical Fusaria	Panama Disease present		
Other Fusaria	Colorado Disease present		

PANAMA DIVISION

SERIAL NUMBER *120*

Location: *Senosri* Farm, Section *; Opposite tram and beef house, 80 meters north of track.*

Date: *October, 1916.*
Collector: *H. D. A.*

Other distinguishing features:

NATURAL FEATURES

Topography: *Bottom land.*
Drainage: *Natural and artificial.*
Flood conditions: *Every year.*
Silt deposition: *Heavy in floods.*
Type of forest growth: *Heavy.*

CULTIVATION HISTORY

When cleared and planted: *1912 by Feild.*
Number of replantings: *One, 1914.* Why? *Taken by U. F.*
General condition when in production: *Fair but increasing.*
Plowed? *No.* When? Grubbed? *No.* When?
Years in bananas: *Four.* Life of farm: *Production increasing.*
Years in bush or fallow: *Never.*
Other crops grown: *1916, reds and cacao.*

DISEASE HISTORY

When first noted: *In early squatters' plantings.*
Age of plants when attacked: *Young.*
Rapidity of spread: *Slow to date, except on hills.*
Treatment given: *Digging out, burning and bleaching.*

OTHER DATA

	Surface—6"	6"—18"	18"—30"
Physical Examination			
Color	light brown	light brown	light brown
Compactness	loose	loose	loose
Friability	light	light	light
Retentive power	50	40	43
Mechanical Examination			
Coarse gravel	0	0	0
Fine gravel	0	0	0
Coarse sand	4.4	1.7	10.2
Fine sand	21.4	33.4	30.2
Silt	71.4	61.8	56.4
Clay	2.8	3.1	3.2
Chemical Examination			
Organic matter	7.14	4.87	3.35
Total Nitrogen	.14	.06	.02
Potash (K_2O)	.40	.38	.23
Phosphoric acid (P_2O_5)	.41	.28	.32
Lime (CaO)	2.28	1.95	1.76
Magnesia (MgO)	1.58	1.32	.34
Iron (Fe_2O_3)	8.49	8.82	9.53
Alumina (Al_2O_3)			
Silica, sol. (SiO_2)			
Free Acidity			
Mycological Examination			
Typical Fusaria	Panama Disease present		
Other Fusaria	Colorado Disease present		

PANAMA DIVISION

SERIAL NUMBER *121*

Location: *Sibubi* Farm, Section *48; 60 meters west of camps, 40 meters south of main line.*

Date: *October, 1916.*
Collector: *H. D. A.*

Other distinguishing features:

NATURAL FEATURES
Topography: *Bottom land.*
Drainage: *Heavy artificial by drains to creek.*
Flood conditions: *About once a year.*
Silt deposition: *Heavy.*
Type of forest growth: *Heavy.*

CULTIVATION HISTORY
When cleared and planted: *1912 by Feild but wet conditions required replanting, after draining.*
Number of replantings: *One, 1915.* Why? *See above.*
General condition when in production: *Poor until drained; since 1916 good.*
Plowed? *No.* When? Grubbed? *No.* When?
Years in bananas: *Four.* Life of farm: *Increasing in production.*
Years in bush or fallow: *Never.*
Other crops grown: *1916, reds and cacao.*

DISEASE HISTORY
When first noted: *1915, on hills now abandoned.*
Age of plants when attacked: *About a year.*
Rapidity of spread: *Slow except in spots.*
Treatment given: *Digging out, burning and bleaching.*

OTHER DATA
Area sampled had died of disease, and planting reds has also been unsuccessful.

	Surface—6″	6″—18″	18″—30″
Physical Examination			
Color	light brown	yellow brown	yellow brown
Compactness	hard	hard	hard
Friability	light	refractory	refractory
Retentive power	86	69	67
Mechanical Examination			
Coarse gravel	0	0	0
Fine gravel	0	0	0
Coarse sand	31.0	7.6	21.9
Fine sand	26.5	20.8	28.8
Silt	36.0	64.9	42.1
Clay	6.5	6.7	7.2
Chemical Examination			
Organic matter	12.71	10.48	11.08
Total Nitrogen	.31	.13	.11
Potash (K_2O)	.27	.35	.35
Phosphoric acid (P_2O_5)	.17	.14	.12
Lime (CaO)	1.65	2.15	1.40
Magnesia (MgO)	.16	1.53	.70
Iron (Fe_2O_3)	9.63	11.23	8.52
Alumina (Al_2O_3)			
Silica, sol. (SiO_2)			
Free Acidity			
Mycological Examination			
Typical Fusaria	Panama Disease present		
Other Fusaria	Colorado Disease present		

PANAMA DIVISION

SERIAL NUMBER *122*

Location: *Sibubi* Farm, Section *93; Close to trail, 200 meters south of end of track.*

Date: *October, 1916.*
Collector: *H. D. A.*

Other distinguishing features:

NATURAL FEATURES

Topography: *Bottom land.*
Drainage: *Heavy artificial from hills to creek.*
Flood conditions: *About once a year.*
Silt deposition: *From an inch up.*
Type of forest growth: *Heavy.*

CULTIVATION HISTORY

When cleared and planted: *1912 by Feild.*
Number of replantings: *One, 1915.* Why? *Wet condition.*
General condition when in production: *Poor before 1915, later increasing.*
Plowed? *No.* When? Grubbed? *No.* When?
Years in bananas: *Four.* Life of farm: *Production increasing.*
Years in bush or fallow: *Never.*
Other crops grown: *1916, some reds and cacao.*

DISEASE HISTORY

When first noted: *1915 on hills.*
Age of plants when attacked: *Less than a year.*
Rapidity of spread: *Slow except in spots on hills.*
Treatment given: *Digging out, burning and bleaching.*

OTHER DATA

Panama Disease evident in scattered mats. Outcropping of stones.

	Surface—6"	6"—18"	18"—30"
Physical Examination			
Color	light brown	yellow brown	yellow brown
Compactness	loose	hard	hard
Friability	light	refractory	refractory
Retentive power	65	59	55
Mechanical Examination			
Coarse gravel	0	0	0
Fine gravel	0	0	9
Coarse sand	0	3.9	29.4
Fine sand	0	17.6	31.3
Silt	93.4	71.6	31.9
Clay	6.6	6.9	7.4
Chemical Examination			
Organic matter	6.78	9.84	8.27
Total Nitrogen	.15	.003	0
Potash (K_2O)	.54	.77	.20
Phosphoric acid (P_2O_5)	.27	.14	.22
Lime (CaO)	.91	1.28	1.07
Magnesia (MgO)	.88	.37	.70
Iron (Fe_2O_3)	11.03	7.77	10.42
Alumina (Al_2O_3)			
Silica, sol. (SiO_2)			
Free Acidity			
Mycological Examination			
Typical Fusaria	Panama Disease present		
Other Fusaria	Colorado Disease present		

PANAMA DIVISION

SERIAL NUMBER *123*

Location: *Dos Canos* Farm, Section *40; Line 37, 40 meters south of track.*

Date: *October, 1916.*
Collector: *H. D. A.*

Other distinguishing features:

NATURAL FEATURES

Topography: *Bottom land.*
Drainage: *Natural and artificial.*
Flood conditions: *About every two years.*
Silt deposition: *One inch to a foot in floods.*
Type of forest growth: *Heavy.*

CULTIVATION HISTORY

When cleared and planted: *1908–9.*
Number of replantings: *One, 1910.* Why? *Heavy flood.*
General condition when in production: *Very good since 1910.*
Plowed? *No.* When? Grubbed? *No.* When?
Years in bananas: *Six.* Life of farm: *Still producing well.*
Years in bush or fallow: *Never.*
Other crops grown: *Some reds and cacao.*

DISEASE HISTORY

When first noted: *About 1908.*
Age of plants when attacked: *Very young.*
Rapidity of spread: *Slowly until 1912, after hurricane more rapid.*
Treatment given: *Digging out, burning and, in 1916, bleaching.*

OTHER DATA

	Surface—6"	6"—18"	18"—30"
Physical Examination			
Color	light brown	light brown	light brown
Compactness	loose	loose	loose
Friability	light	light	light
Retentive power	94	67	56
Mechanical Examination			
Coarse gravel	0	0	0
Fine gravel	0	0	0
Coarse sand	25.1	25.6	24.3
Fine sand	31.8	29.5	27.2
Silt	35.8	39.1	42.4
Clay	7.3	5.8	6.1
Chemical Examination			
Organic matter	18.05	8.07	9.50
Total Nitrogen	.63	.17	.10
Potash (K_2O)	.13	.54	.48
Phosphoric acid (P_2O_5)	.37	.16	.25
Lime (CaO)	1.64	1.13	1.08
Magnesia (MgO)	.26	.72	.25
Iron (Fe_2O_3)	9.78	10.81	9.24
Alumina (Al_2O_3)			
Silica, sol. (SiO_2)			
Free Acidity			
Mycological Examination			
Typical Fusaria	Panama Disease present		
Other Fusaria	Colorado Disease present		

PANAMA DIVISION

SERIAL NUMBER *124*

Location: *Favorita* Farm, Section *10; 50 meters from line 10–11, 20 meters east of line 20.*

Date: *November, 1916.*
Collector: *H. D. A.*

Other distinguishing features:

NATURAL FEATURES

Topography: *Bottom land.*
Drainage: *Natural and artificial.*
Flood conditions: *Yearly.*
Silt deposition: *From an inch up, in floods.*
Type of forest growth: *Heavy.*

CULTIVATION HISTORY

When cleared and planted: *1904 and abandoned until 1907–8.*
Number of replantings: *One, 1907–8.* Why? *Taken over by U. F. Co.*
General condition when in production: *Very good from 1909 until flood of 1915.*
Plowed? *No.* When? Grubbed? *No.* When?
Years in bananas: *Twelve.* Life of farm: *Still good producer.*
Years in bush or fallow: *Never, except 1904–7.*
Other crops grown: *1916, reds and cacao.*

DISEASE HISTORY

When first noted: *1906, but very little increase until 1914.*
Age of plants when attacked: *Two years.*
Rapidity of spread: *Slow until 1914, then more rapid.*
Treatment given: *Digging out, burning and bleaching.*

OTHER DATA

This is an old American Banana Company planting. Very little disease even now.

	Surface—6"	6"—18"	18"—30"
Physical Examination			
Color	light brown	light brown	light brown
Compactness	loose	loose	loose
Friability	light	light	light
Retentive power	66	63	59
Mechanical Examination			
Coarse gravel	0	0	0
Fine gravel	0	0	0
Coarse sand	20.3	21.7	13.2
Fine sand	51.6	23.8	31.0
Silt	22.1	46.8	48.4
Clay	6.0	7.7	7.4
Chemical Examination			
Organic matter	9.20	8.69	8.78
Total Nitrogen	.14	.15	.21
Potash (K_2O)	.38	.46	.48
Phosphoric acid (P_2O_5)	.31	.35	.10
Lime (CaO)	1.75	1.72	1.67
Magnesia (MgO)	1.68	.43	.65
Iron (Fe_2O_3)	9.35	8.82	6.08
Alumina (Al_2O_3)			
Silica, sol. (SiO_2)			
Free Acidity			
Mycological Examination			
Typical Fusaria	Panama Disease present		
Other Fusaria	Colorado Disease present		

PANAMA DIVISION

SERIAL NUMBER *125*

Location: *Talamanca C* Farm, Section *; Near railroad south of Amouri River.*

Date: *October, 1916.*
Collector: *H. D. A.*

Other distinguishing features:

NATURAL FEATURES

Topography: *Bottom land.*
Drainage: *Natural.*
Flood conditions: *Only in very high water.*
Silt deposition: *Very little.*
Type of forest growth: *Heavy virgin woodland.*

CULTIVATION HISTORY

When cleared and planted: *Original woodland.*
Number of replantings: Why?
General condition when in production:
Plowed? When? Grubbed? When?
Years in bananas: Life of farm:
Years in bush or fallow:
Other crops grown:

DISEASE HISTORY

When first noted:
Age of plants when attacked:
Rapidity of spread:
Treatment given:

OTHER DATA

	Surface—6"	6"—18"	18"—30"
Physical Examination			
Color	dark brown	dark brown	dark brown
Compactness	loose	loose	loose
Friability	light	light	light
Retentive power	62	48	39
Mechanical Examination			
Coarse gravel	0	0	0
Fine gravel	0	0	0
Coarse sand	11.8	8.7	20.4
Fine sand	43.1	47.8	50.6
Silt	39.3	40.5	25.2
Clay	5.8	3.0	3.8
Chemical Examination			
Organic matter	11.73	4.91	4.23
Total Nitrogen	.29	.08	.07
Potash (K_2O)	.35	.45	.16
Phosphoric acid (P_2O_5)	1.15	.34	.31
Lime (CaO)	3.03	2.82	2.10
Magnesia (MgO)	.45	1.59	.23
Iron (Fe_2O_3)	8.15	8.03	11.65
Alumina (Al_2O_3)			
Silica, sol. (SiO_2)			
Free Acidity			
Mycological Examination			
Typical Fusaria			
Other Fusaria			

PANAMA DIVISION

SERIAL NUMBER *126*

Location: *Talamanca* Farm, Section *; Bank of Tilire River, near pasture formerly owned by Henri.*

Date: *October, 1916.*
Collector: *H. D. A.*

Other distinguishing features:

NATURAL FEATURES

Topography: *Bottom land.*
Drainage: *Natural.*
Flood conditions: *Probably in heavy floods.*
Silt deposition: *Heavy.*
Type of forest growth: *Scattered large growth, heavy underbrush.*

CULTIVATION HISTORY

When cleared and planted: *Virgin woodland.*
Number of replantings: Why?
General condition when in production:
Plowed? When? Grubbed? When?
Years in bananas: Life of farm:
Years in bush or fallow:
Other crops grown:

DISEASE HISTORY

When first noted:
Age of plants when attacked:
Rapidity of spread:
Treatment given:

OTHER DATA

	Surface—6"	6"—18"	18"—30"
Physical Examination			
Color	dark brown	dark brown	dark brown
Compactness	loose	loose	loose
Friability	light	light	light
Retentive power	60	48	59
Mechanical Examination			
Coarse gravel	0	0	0
Fine gravel	0	0	0
Coarse sand	11.3	0	13.6
Fine sand	49.8	15.2	25.2
Silt	35.7	81.5	56.3
Clay	3.2	3.3	4.9
Chemical Examination			
Organic matter	6.27	6.53	7.03
Total Nitrogen	.16	.01	.12
Potash (K_2O)	.37	.44	.48
Phosphoric acid (P_2O_5)	.32	.31	.14
Lime (CaO)	2.70	2.33	1.81
Magnesia (MgO)	1.22	.58	1.56
Iron (Fe_2O_3)	12.38	10.72	9.07
Alumina (Al_2O_3)			
Silica, sol. (SiO_2)			
Free Acidity			
Mycological Examination			
Typical Fusaria			
Other Fusaria			

PANAMA DIVISION

SERIAL NUMBER *127*

Location: *Talamanca B* Farm, Section *20; About 200 meters north of Ramon's place.*

Date: *October, 1916.*
Collector: *H. D. A.*

Other distinguishing features:

NATURAL FEATURES

Topography: *Bottom land.*
Drainage: *Natural, good.*
Flood conditions: *Repeated floods.*
Silt deposition: *Heavy.*
Type of forest growth:

CULTIVATION HISTORY

When cleared and planted: *April, 1916, fine stand of vigorous plants.*
Number of replantings: *None.* Why? *First planting.*
General condition when in production:
Plowed? When? Grubbed? When?
Years in bananas: Life of farm:
Years in bush or fallow:
Other crops grown:

DISEASE HISTORY

When first noted: *None has appeared.*
Age of plants when attacked:
Rapidity of spread:
Treatment given:

OTHER DATA

	Surface—6"	6"—18"	18"—30"
Physical Examination			
Color	light brown	light brown	light brown
Compactness	loose	loose	loose
Friability	light	light	light
Retentive power	66	55	56
Mechanical Examination			
Coarse gravel	0	0	0
Fine gravel	0	0	0
Coarse sand	16.5	10.8	15.2
Fine sand	22.6	19.0	22.7
Silt	56.5	66.3	59.2
Clay	4.4	3.9	2.9
Chemical Examination			
Organic matter	10.35	7.63	6.05
Total Nitrogen	.33	.13	.08
Potash (K_2O)	.25	.36	.36
Phosphoric acid (P_2O_5)	.22	.43	.43
Lime (CaO)	3.62	2.37	2.98
Magnesia (MgO)	1.41	.86	1.43
Iron (Fe_2O_3)	10.09	8.50	9.97
Alumina (Al_2O_3)			
Silica, sol. (SiO_2)			
Free Acidity			
Mycological Examination			
Typical Fusaria			
Other Fusaria			

PANAMA DIVISION

SERIAL NUMBER *128*

Location: *Talamanca* Farm, Section ; *Near Sipurio, corner of old pasture fence near trail.*

Date: *October, 1916.*
Collector: *H. D. A.*

Other distinguishing features:

NATURAL FEATURES

Topography: *Bottom land.*
Drainage: *Good.*
Flood conditions: *Occasional.*
Silt deposition: *Slight.*
Type of forest growth: *Heavy virgin woodland.*

CULTIVATION HISTORY

When cleared and planted: *Possibly Indian cultivations nearby.*
Number of replantings: Why?
General condition when in production:
Plowed? When? Grubbed? When?
Years in bananas: Life of farm:
Years in bush or fallow:
Other crops grown:

DISEASE HISTORY

When first noted:
Age of plants when attacked:
Rapidity of spread:
Treatment given:

OTHER DATA

	Surface—6"	6"—18"	18"—30"
Physical Examination			
Color	light brown	light brown	light brown
Compactness	loose	loose	loose
Friability	light	light	light
Retentive power	44	43	50
Mechanical Examination			
Coarse gravel	0	0	0
Fine gravel	0	0	0
Coarse sand	6.0	5.9	11.3
Fine sand	42.3	18.0	17.4
Silt	50.1	74.1	69.1
Clay	1.6	2.0	2.2
Chemical Examination			
Organic matter	6.55	4.27	3.87
Total Nitrogen	.11	.12	.12
Potash (K_2O)	.19	.22	.39
Phosphoric acid (P_2O_5)	.26	.30	.42
Lime (CaO)	2.22	1.46	1.63
Magnesia (MgO)	.54	1.36	1.23
Iron (Fe_2O_3)	9.37	7.72	7.43
Alumina (Al_2O_3)			
Silica, sol. (SiO_2)			
Free Acidity			
Mycological Examination			
Typical Fusaria			
Other Fusaria			

PANAMA DIVISION

SERIAL NUMBER *129*

Location: *Talamanca* Farm, Section ; *Amubri region.* Date: *October, 1916.*

Other distinguishing features: *100 meters west of padre's house on trail from Amubri to Lari.* Collector: *H. D. A.*

NATURAL FEATURES

Topography: *Bottom land.*
Drainage: *Natural.*
Flood conditions: *Occasional.*
Silt deposition: *Slight.*
Type of forest growth: *Heavy virgin woodland.*

CULTIVATION HISTORY

When cleared and planted: *Never cleared.*
Number of replantings: Why?
General condition when in production:
Plowed? When? Grubbed? When?
Years in bananas: Life of farm:
Years in bush or fallow:
Other crops grown:

DISEASE HISTORY

When first noted:
Age of plants when attacked:
Rapidity of spread:
Treatment given:

OTHER DATA

	Surface—6"	6"—18"	18"—30"
Physical Examination			
Color	light brown	light brown	light brown
Compactness	loose	loose	loose
Friability	light	light	light
Retentive power	68	38	28
Mechanical Examination			
Coarse gravel	0	0	some stones
Fine gravel	0	0	21.5
Coarse sand	0	0	19.1
Fine sand	13.2	0	35.6
Silt	83.6	97.8	22.0
Clay	3.2	2.2	1.8
Chemical Examination			
Organic matter	9.25	3.83	2.98
Total Nitrogen	.33	.07	.24
Potash (K_2O)	.48	.40	.35
Phosphoric acid (P_2O_5)	.30	.42	.45
Lime (CaO)	2.79	1.26	1.26
Magnesia (MgO)	.79	1.01	.90
Iron (Fe_2O_3)	7.83	7.05	9.15
Alumina (Al_2O_3)			
Silica, sol. (SiO_2)			
Free Acidity			
Mycological Examination			
Typical Fusaria			
Other Fusaria			

PANAMA DIVISION

SERIAL NUMBER *130*

Location: *Talamanca* Farm, Section ; *Near Lari main trail to Sipurio, Lightburn tract.*

Date: *October, 1916.*
Collector: *H. D. A.*

Other distinguishing features:

NATURAL FEATURES

Topography: *Bottom land.*
Drainage: *Natural.*
Flood conditions: *Frequent.*
Silt deposition: *Slight.*
Type of forest growth: *Heavy.*

CULTIVATION HISTORY

When cleared and planted: *Virgin woodland, squatters' plantings near.*
Number of replantings: Why?
General condition when in production:
Plowed? When? Grubbed? When?
Years in bananas: Life of farm:
Years in bush or fallow:
Other crops grown:

DISEASE HISTORY

When first noted:
Age of plants when attacked:
Rapidity of spread:
Treatment given:

OTHER DATA

	Surface—6"	6"—18"	18"—30"
Physical Examination			
Color	light brown	dark brown	brown
Compactness	loose	loose	loose
Friability	light	light	light
Retentive power	77	62	32
Mechanical Examination			
Coarse gravel	0	0	0
Fine gravel	0	3.3	0.5
Coarse sand	13.5	19.7	1.5
Fine sand	34.5	36.9	44.3
Silt	47.8	37.3	52.1
Clay	4.2	2.8	1.6
Chemical Examination			
Organic matter	13.01	4.67	1.98
Total Nitrogen	.50	.15	.06
Potash (K_2O)	.40	.37	.38
Phosphoric acid (P_2O_5)	.24	.31	.20
Lime (CaO)	1.78	1.25	1.19
Magnesia (MgO)	1.48	.85	1.10
Iron (Fe_2O_3)	6.62	6.64	7.49
Alumina (Al_2O_3)			
Silica, sol. (SiO_2)			
Free Acidity			
Mycological Examination			
Typical Fusaria			
Other Fusaria			

PANAMA DIVISION

SERIAL NUMBER *131*

Location: *Talamanca* Farm, Section *; Woodland.*

Other distinguishing features: *100 meters beyond Xirukitcha ranch, by mountain trail.*

Date: *October, 1916.*

Collector: *H. D. A.*

NATURAL FEATURES

Topography: *Bottom land.*
Drainage: *Naturally well drained.*
Flood conditions: *Only in highest water.*
Silt deposition: *Heavy in floods.*
Type of forest growth: *Heavy virgin woodland.*

CULTIVATION HISTORY

When cleared and planted: *Never.*
Number of replantings: Why?
General condition when in production:
Plowed? When? Grubbed? When?
Years in bananas: Life of farm:
Years in bush or fallow:
Other crops grown:

DISEASE HISTORY

When first noted:
Age of plants when attacked:
Rapidity of spread:
Treatment given:

OTHER DATA

	Surface—6"	6"—18"	18"—30"
Physical Examination			
Color	dark brown	dark brown	brown
Compactness	loose	loose	loose
Friability	light	light	light
Retentive power	79	52	38
Mechanical Examination			
Coarse gravel	0	0	0
Fine gravel	1.5	4.5	4.0
Coarse sand	27.2	32.2	37.2
Fine sand	52.9	43.8	42.1
Silt	13.2	15.5	12.7
Clay	5.2	4.0	4.0
Chemical Examination			
Organic matter	11.97	9.15	4.57
Total Nitrogen	.42	.14	.04
Potash (K_2O)	.39	.18	.33
Phosphoric acid (P_2O_5)	.35	.46	1.16
Lime (CaO)	1.11	1.55	2.36
Magnesia (MgO)	.48	1.11	.43
Iron (Fe_2O_3)	13.68	11.97	14.72
Alumina (Al_2O_3)			
Silica, sol. (SiO_2)			
Free Acidity			
Mycological Examination			
Typical Fusaria			
Other Fusaria			

PANAMA DIVISION

SERIAL NUMBER *132*

Location: *Talamanca* Farm, Section ; *Along trail 200 meters from Coroma settlement.*

Date: *October, 1916.*
Collector: *H. D. A.*

Other distinguishing features:

NATURAL FEATURES

Topography: *Bottom land.*
Drainage: *Good, natural.*
Flood conditions: *Frequent.*
Silt deposition: *More washing than deposit.*
Type of forest growth: *Heavy.*

CULTIVATION HISTORY

When cleared and planted: *Virgin woodland.*
Number of replantings: Why?
General condition when in production:
Plowed? When? Grubbed? When?
Years in bananas: Life of farm:
Years in bush or fallow:
Other crops grown:

DISEASE HISTORY

When first noted:
Age of plants when attacked:
Rapidity of spread:
Treatment given:

OTHER DATA

	Surface—6"	6"—18"	18"—30"
Physical Examination			
Color	brown	light brown	light brown
Compactness	loose	loose	loose
Friability	light	light	light
Retentive power	60	55	42
Mechanical Examination			
Coarse gravel	0	0	small stones
Fine gravel	2.5	0	0.6
Coarse sand	0.8	13.7	13.1
Fine sand	14.2	65.2	23.8
Silt	78.3	17.1	60.2
Clay	4.2	4.0	2.3
Chemical Examination			
Organic matter	10.05	5.96	5.33
Total Nitrogen	.33	.16	.07
Potash (K_2O)	.47	.26	.47
Phosphoric acid (P_2O_5)	.15	.68	.21
Lime (CaO)	1.45	1.74	.84
Magnesia (MgO)	1.07	.43	1.48
Iron (Fe_2O_3)	4.63	5.30	7.52
Alumina (Al_2O_3)			
Silica, sol. (SiO_2)			
Free Acidity			
Mycological Examination			
Typical Fusaria			
Other Fusaria			

PANAMA DIVISION

SERIAL NUMBER *133*

Location: *Talamanca* Farm, Section *; Woodland, 200 meters from Ramerez place and 40 meters from small creek.*

Date: *October, 1916.*
Collector: *H. D. A.*

Other distinguishing features:

NATURAL FEATURES

Topography: *Bottom land.*
Drainage: *Natural, good.*
Flood conditions: *Probably frequently.*
Silt deposition: *Very little.*
Type of forest growth: *Heavy.*

CULTIVATION HISTORY

When cleared and planted: *Virgin woodland.*
Number of replantings: Why?
General condition when in production:
Plowed? When? Grubbed? When?
Years in bananas: Life of farm:
Years in bush or fallow:
Other crops grown:

DISEASE HISTORY

When first noted:
Age of plants when attacked:
Rapidity of spread:
Treatment given:

OTHER DATA

	Surface—6"	6"—18"	18"—30"
PHYSICAL EXAMINATION			
Color	light brown	light brown	light brown
Compactness	loose	loose	loose
Friability	light	light	light
Retentive power	79	69	56
MECHANICAL EXAMINATION			
Coarse gravel	0	small stones	small stones
Fine gravel	0	0	0
Coarse sand	11.2	10.6	13.4
Fine sand	32.8	25.1	27.4
Silt	49.8	58.8	52.1
Clay	6.2	5.5	7.1
CHEMICAL EXAMINATION			
Organic matter	14.46	8.93	8.89
Total Nitrogen	.49	.02	.08
Potash (K_2O)	.09	.46	.35
Phosphoric acid (P_2O_5)	.27	.05	.19
Lime (CaO)	.81	.99	.96
Magnesia (MgO)	.14	.75	.68
Iron (Fe_2O_3)	8.62	10.00	11.40
Alumina (Al_2O_3)			
Silica, sol. (SiO_2)			
Free Acidity			
MYCOLOGICAL EXAMINATION			
Typical Fusaria			
Other Fusaria			

PANAMA DIVISION

SERIAL NUMBER *134*

Location: *Talamanca* Farm, Section ; *Tsepeque seed bed on west side of Tsepeque River.*

Date: *October, 1916.*
Collector: *H. D. A.*

Other distinguishing features:

NATURAL FEATURES

Topography: *Bottom land.*
Drainage: *Natural.*
Flood conditions: *Only in very high water.*
Silt deposition: *No recent deposits.*
Type of forest growth: *Light.*

CULTIVATION HISTORY

When cleared and planted: *Virgin woodland.*
Number of replantings: Why?
General condition when in production:
Plowed? When? Grubbed? When?
Years in bananas: Life of farm:
Years in bush or fallow:
Other crops grown:

DISEASE HISTORY

When first noted:
Age of plants when attacked:
Rapidity of spread:
Treatment given:

OTHER DATA

	Surface—6"	6"—18"	18"—30"
PHYSICAL EXAMINATION			
Color	dark brown	light brown	brown
Compactness	loose	loose	loose
Friability	light	light	light
Retentive power	73	44	37
MECHANICAL EXAMINATION			
Coarse gravel	0	0	0
Fine gravel	0	0	0
Coarse sand	14.4	11.5	8.4
Fine sand	33.7	43.5	58.1
Silt	47.1	42.3	30.2
Clay	4.8	2.7	3.3
CHEMICAL EXAMINATION			
Organic matter	11.82	5.04	5.23
Total Nitrogen	.41	.09	.05
Potash (K_2O)	.39	.35	.18
Phosphoric acid (P_2O_5)	.29	.26	.84
Lime (CaO)	2.03	1.93	1.98
Magnesia (MgO)	1.69	.97	.29
Iron (Fe_2O_3)	7.73	9.34	9.16
Alumina (Al_2O_3)			
Silica, sol. (SiO_2)			
Free Acidity			
MYCOLOGICAL EXAMINATION			
Typical Fusaria			
Other Fusaria			

PANAMA DIVISION

SERIAL NUMBER *135*

Location: *Olivia* Farm, Section *15; 20 meters north of pasture fence, 20 meters west of main railroad line.*

Date: *November, 1916.*
Collector: *H. D. A.*

Other distinguishing features:

NATURAL FEATURES

Topography: *Bottom land.*
Drainage: *Natural toward river.*
Flood conditions: *Once every two years.*
Silt deposition: *From one inch to a foot in floods.*
Type of forest growth: *Heavy.*

CULTIVATION HISTORY

When cleared and planted: *1910–11.*
Number of replantings: *None.* Why?
General condition when in production: *Very good.*
Plowed? *No.* When? Grubbed? *No.* When?
Years in bananas: *Five.* Life of farm: *Still producing well.*
Years in bush or fallow: *Never.*
Other crops grown: *Some reds and cacao.*

DISEASE HISTORY

When first noted: *Colorado Disease since 1913, Panama Disease about the same.*
Age of plants when attacked: *About three years.*
Rapidity of spread: *Slow.*
Treatment given: *Digging out, burning and bleaching.*

OTHER DATA

This area has been practically abandoned because of Colorado Disease, but in 1915–16 was reclaimed by burning diseased mats, thorough cleaning, and heavy mulching; results appear to be good.

	Surface—6"	6"—18"	18"—30"
Physical Examination			
Color	light brown	light brown	light brown
Compactness	loose	loose	loose
Friability	light	light	light
Retentive power	76	61	57
Mechanical Examination			
Coarse gravel	0	0	0
Fine gravel	0	0	0
Coarse sand	24.2	23.9	14.4
Fine sand	24.6	22.0	18.7
Silt	45.8	48.8	61.9
Clay	5.4	5.3	5.0
Chemical Examination			
Organic matter	10.33	7.54	6.95
Total Nitrogen	.28	.11	.13
Potash (K_2O)	.22	.37	.40
Phosphoric acid (P_2O_5)	.27	.43	1.06
Lime (CaO)	2.21	2.12	2.50
Magnesia (MgO)	1.24	1.16	1.85
Iron (Fe_2O_3)	8.93	9.34	9.00
Alumina (Al_2O_3)			
Silica, sol. (SiO_2)			
Free Acidity			
Mycological Examination			
Typical Fusaria	Panama Disease present		
Other Fusaria	Colorado Disease present		

PANAMA DIVISION

SERIAL NUMBER *136*

Location: *Changuinola 4* Farm, Section *8e; Division line 7e–8e, 75 meters from track.*

Date: *February, 1917.*
Collector: *H. D. A.*

Other distinguishing features:

NATURAL FEATURES

Topography: *Bottom land.*
Drainage: *Natural.*
Flood conditions: *No floods for ten years or more.*
Silt deposition: *None.*
Type of forest growth: *Probably heavy.*

CULTIVATION HISTORY

When cleared and planted: *1904.*
Number of replantings: *None.* Why?
General condition when in production: *Poor.*
Plowed? *No.* When? Grubbed? *No.* When?
Years in bananas: *Four.* Life of farm: *Abandoned 1909.*
Years in bush or fallow: *Never.*
Other crops grown: *Cacao in 1909, reds as shade in 1914.*

DISEASE HISTORY

When first noted: *1908.*
Age of plants when attacked: *Four years.*
Rapidity of spread: *Very rapid.*
Treatment given: *None.*

OTHER DATA

	Surface—6"	6"—18"	18"—30"
PHYSICAL EXAMINATION			
Color	light brown	light brown	light brown
Compactness	loose	loose	loose
Friability	light	light	light
Retentive power	59	60	58
MECHANICAL EXAMINATION			
Coarse gravel	0	0	0
Fine gravel	0	0	0
Coarse sand	0	19.3	0
Fine sand	0	21.2	0.8
Silt	95.7	54.9	94.8
Clay	4.3	4.6	4.4
CHEMICAL EXAMINATION			
Organic matter	8.13	7.66	6.16
Total Nitrogen	.13	.16	.06
Potash (K_2O)	.39	.39	.29
Phosphoric acid (P_2O_5)	.22	.38	.20
Lime (CaO)	1.48	1.69	1.87
Magnesia (MgO)	1.61	1.14	2.25
Iron (Fe_2O_3)	9.44	9.70	10.63
Alumina (Al_2O_3)			
Silica, sol. (SiO_2)			
Free Acidity			
MYCOLOGICAL EXAMINATION			
Typical Fusaria	Panama Disease present		
Other Fusaria			

PANAMA DIVISION

SERIAL NUMBER *137*

Location: *Changuinola* Farm, Section *20f; Near line 20–21, 20 meters from railroad (formerly section 20—Farm 5).*

Date: *February, 1917.*
Collector: *H. D. A.*

Other distinguishing features:

NATURAL FEATURES
Topography: *Bottom land.*
Drainage: *Natural to creek.*
Flood conditions: *None for eight years.*
Silt deposition: *Not frequent.*
Type of forest growth: *Probably heavy.*

CULTIVATION HISTORY
When cleared and planted: *1904.*
Number of replantings: *None.* Why?
General condition when in production: *Good.*
Plowed? *No.* When? Grubbed? *No.* When?
Years in bananas: *Twelve.* Life of farm: *Part still good.*
Years in bush or fallow: *None.*
Other crops grown: *Cocoanuts in 1917.*

DISEASE HISTORY
When first noted: *1913.*
Age of plants when attacked: *Nine years.*
Rapidity of spread: *Slow; half of section still good.*
Treatment given: *None.*

OTHER DATA

	Surface—6"	6"—18"	18"—30"
Physical Examination			
Color	light brown	light brown	light brown
Compactness	loose	loose	loose
Friability	light	light	light
Retentive power	55	66	62
Mechanical Examination			
Coarse gravel	0	0	0
Fine gravel	0	0	0
Coarse sand	26.0	0	20.7
Fine sand	26.1	0	23.3
Silt	41.2	92.5	50.7
Clay	6.7	7.5	5.4
Chemical Examination			
Organic matter	15.28	12.30	8.70
Total Nitrogen	.51	.12	.11
Potash (K_2O)	.39	.69	.13
Phosphoric acid (P_2O_5)	.49	.34	.24
Lime (CaO)	2.36	1.75	2.03
Magnesia (MgO)	1.64	.64	1.37
Iron (Fe_2O_3)	8.31	10.16	10.96
Alumina (Al_2O_3)			
Silica, sol. (SiO_2)			
Free Acidity			
Mycological Examination			
Typical Fusaria	Panama Disease present		
Other Fusaria			

PANAMA DIVISION

SERIAL NUMBER *138*

Location: *Changuinola 2* Farm, Section *11; Division line 11–13, 50 meters from track.*

Date: *February, 1917.*
Collector: *H. D. A.*

Other distinguishing features:

NATURAL FEATURES

Topography: *Bottom land.*
Drainage: *Natural.*
Flood conditions: *No floods for ten years.*
Silt deposition: *Very little.*
Type of forest growth: *Probably heavy.*

CULTIVATION HISTORY

When cleared and planted: *1903.*
Number of replantings: *None.* Why?
General condition when in production: *Very good for ten years.*
Plowed? *No.* When? Grubbed? *No.* When?
Years in bananas: *Thirteen.* Life of farm: *Still producing.*
Years in bush or fallow: *Never.*
Other crops grown: *1916, cacao planted.*

DISEASE HISTORY

When first noted: *1913.*
Age of plants when attacked: *Ten years.*
Rapidity of spread: *Very slow.*
Treatment given: *None.*

OTHER DATA

	Surface—6"	6"—18"	18"—30"
Physical Examination			
Color	light brown	light brown	light brown
Compactness	loose	loose	loose
Friability	light	light	light
Retentive power	68	57	58
Mechanical Examination			
Coarse gravel	0	0	0
Fine gravel	0	0	0
Coarse sand	25.1	20.0	21.4
Fine sand	24.2	19.9	22.2
Silt	43.2	54.8	50.8
Clay	7.5	5.3	5.6
Chemical Examination			
Organic matter	9.35	6.85	6.78
Total Nitrogen	.31	.12	.12
Potash (K_2O)	.38	.21	.48
Phosphoric acid (P_2O_5)	.35	.24	.25
Lime (CaO)	1.84	1.83	1.62
Magnesia (MgO)	1.68	.89	1.62
Iron (Fe_2O_3)	9.07	8.79	8.71
Alumina (Al_2O_3)			
Silica, sol. (SiO_2)			
Free Acidity			
Mycological Examination			
Typical Fusaria	Panama Disease present		
Other Fusaria			

PANAMA DIVISION

SERIAL NUMBER *139*

Location: *Changuinola 8* Farm, Section *67*. Date: *February, 1917.*

Other distinguishing features: Collector: *H. D. A.*

NATURAL FEATURES

Topography: *Bottom land.*
Drainage: *Open ditches.*
Flood conditions: *Yearly overflow.*
Silt deposition: *Considerable.*
Type of forest growth: *Heavy.*

CULTIVATION HISTORY

When cleared and planted: *1905–6.*
Number of replantings: *None.* Why?
General condition when in production: *Always poor.*
Plowed? *No.* When? Grubbed? *No.* When?
Years in bananas: *Six.* Life of farm: *Abandoned 1912.*
Years in bush or fallow: *Since 1913.*
Other crops grown: *Chinese bananas planted 1912 and abandoned 1913.*

DISEASE HISTORY

When first noted: *1909.*
Age of plants when attacked: *Three years.*
Rapidity of spread: *Rapid.*
Treatment given: *None.*

OTHER DATA

	Surface—6"	6"—18"	18"—30"
Physical Examination			
Color	light brown	light brown	light brown
Compactness	loose	loose	loose
Friability	light	light	light
Retentive power	72	59	61
Mechanical Examination			
Coarse gravel	0	0	0
Fine gravel	0	0	0
Coarse sand	0	19.3	14.6
Fine sand	0	29.5	32.1
Silt	94.5	46.5	48.9
Clay	5.5	4.7	4.4
Chemical Examination			
Organic matter	11.08	9.37	6.00
Total Nitrogen	.15	.15	.04
Potash (K_2O)	.48	.53	.54
Phosphoric acid (P_2O_5)	.32	.18	.49
Lime (CaO)	2.33	1.19	1.16
Magnesia (MgO)	.81	.85	.88
Iron (Fe_2O_3)	10.19	9.20	7.32
Alumina (Al_2O_3)			
Silica, sol. (SiO_2)			
Free Acidity			
Mycological Examination			
Typical Fusaria	Panama Disease present		
Other Fusaria			

PANAMA DIVISION

Serial Number *140*

Location: *Changuinola 8* Farm, Section *43t* (*formerly Farm 10, Section 43*). Date: *February, 1917.* Collector: *H. D. A.*

Other distinguishing features:

Natural Features

Topography: *Bottom land.*
Drainage: *Open ditches.*
Flood conditions: *None since 1909.*
Silt deposition: *Heavy in 1909, none since.*
Type of forest growth: *Probably heavy.*

Cultivation History

When cleared and planted: *1904.*
Number of replantings: *None.* Why?
General condition when in production: *Good.*
Plowed? *No.* When? Grubbed? *No.* When?
Years in bananas: *Twelve.* Life of farm: *Still producing well.*
Years in bush or fallow: *Never.*
Other crops grown: *None.*

Disease History

When first noted: *1915.*
Age of plants when attacked: *Eleven.*
Rapidity of spread: *Slow.*
Treatment given: *None.*

Other Data

	Surface—6"	6"—18"	18"—30"
Physical Examination			
Color	light brown	light brown	light brown
Compactness	loose	loose	loose
Friability	light	light	light
Retentive power	49	64	67
Mechanical Examination			
Coarse gravel	0	0	0
Fine gravel	0	0	0
Coarse sand	15.5	20.5	0
Fine sand	22.4	21.7	0
Silt	58.9	52.0	94.0
Clay	3.2	5.8	6.0
Chemical Examination			
Organic matter	7.21	8.97	8.53
Total Nitrogen	.16	.18	.004
Potash (K_2O)	.43	.25	.31
Phosphoric acid (P_2O_5)	.46	.24	.21
Lime (CaO)	2.06	1.08	1.93
Magnesia (MgO)	.83	.62	2.21
Iron (Fe_2O_3)	7.97	2.08	9.86
Alumina (Al_2O_3)			
Silica, sol. (SiO_2)			
Free Acidity			
Mycological Examination			
Typical Fusaria	Panama Disease present		
Other Fusaria			

AVERAGE ANALYSES—PANAMA

Sample	Fine Gravel	Coarse Sand	Fine Sand	Silt	Clay	K_2O	CaO	MgO	Fe_2O_3	P_2O_5	Vol. Mat.	Tot. N	RP
Chase	.0	7.1	26.9	60.8	5.2	.57	1.93	1.28	8.70	.51	8.30	.18	62
Chase	.0	14.8	23.6	55.0	6.6	.27	.74	1.09	7.11	.38	8.32	.14	71
Paraiso	.0	25.0	28.4	41.4	5.2	.41	1.43	.79	8.85	.14	9.81	.17	70
La Celia	.0	11.2	18.0	65.9	4.9	.30	2.35	1.28	8.79	.27	5.56	.11	56
Isla Grande	.0	7.2	12.4	75.6	4.8	.46	1.99	.82	8.11	.20	6.07	.11	50
La Celia	.0	10.4	51.3	34.3	4.0	.24	1.91	1.33	9.26	.20	6.77	.14	61
Daytonia	.0	15.2	16.1	63.6	5.1	.50	1.84	1.29	8.38	.27	7.84	.17	65
Costa Rica	.0	19.0	31.1	44.0	5.9	.32	1.45	.71	9.71	.26	9.34	.18	74
Costa Rica	.0	7.5	16.6	70.8	5.1	.40	2.12	1.64	9.52	.43	7.61	.08	55
Jose	.0.1	17.1	30.7	43.8	6.3	.48	1.78	.82	9.87	.20	11.61	.23	68
Drury	.0	27.6	30.9	34.0	7.5	.29	1.46	1.20	11.27	.21	12.45	.21	79
Margarita	.0	4.5	20.8	71.1	3.6	.51	2.17	1.44	9.14	.25	8.00	.11	48
Margarita	.0	8.9	17.2	70.2	3.7	.24	2.17	.91	7.98	.16	6.29	.15	54
Catarina	.0	13.8	22.1	59.2	4.9	.42	2.42	.93	8.48	.32	8.29	.15	62
Nievecito	.0	12.8	12.9	68.4	5.9	.27	.97	.58	10.09	.24	10.31	.06	69
Riverside	.0	7.5	16.7	71.7	4.1	.53	2.30	2.16	8.40	.09	6.88	.14	57
Riverside	.0	36.8	30.8	25.1	7.3	.41	1.62	.78	9.87	.27	10.26	.12	77
Barranco	.0	28.3	29.4	35.5	6.8	.23	1.65	.79	8.84	.32	9.84	.22	73
Elena	.0	8.0	25.0	63.7	3.3	.21	1.27	1.15	8.06	.27	5.75	.11	47
Senosri	.0	5.6	29.7	61.6	3.1	.32	1.92	.98	9.04	.32	4.71	.04	43
Sibubi	.0	18.0	25.1	50.0	6.9	.33	1.75	.92	9.83	.14	11.16	.16	72
Sibubi	.0	13.3	19.5	60.1	7.1	.49	1.12	.60	9.48	.20	8.60	.03	59
Dos Canos	.0	25.0	29.1	39.7	6.2	.43	1.21	.44	9.98	.24	10.64	.23	68
Favorita	.0	18.0	32.3	42.5	7.2	.45	1.71	.77	7.83	.24	8.83	.17	62

Talamanca	.0	14.0	48.0	34.1	3.9	.31	2.57	.82	9.50	.49	6.00	.11	47
Talamanca	.0	7.7	26.1	62.3	3.9	.44	2.19	1.10	10.39	.24	6.68	.08	55
Talamanca	.0	13.7	21.2	61.5	3.6	.34	2.86	1.20	9.41	.39	7.54	.15	57
Talamanca	.0	8.1	22.6	67.3	2.0	.28	1.68	1.14	7.93	.33	4.56	.12	46
Talamanca	.8.6	7.8	16.8	64.6	2.2	.39	1.56	.92	8.05	.41	4.57	.19	40
Talamanca	.1.5	11.2	39.4	45.3	2.6	.38	1.33	1.07	6.97	.25	5.26	.18	53
Talamanca	.3.7	33.2	44.9	13.9	4.3	.28	1.78	.71	13.41	.72	7.88	.15	52
Talamanca	.0.7	10.9	38.4	46.6	3.4	.39	1.32	.98	6.05	.38	6.52	.16	51
Talamanca	.0	11.8	27.5	54.4	6.3	.34	.94	.60	10.28	.15	10.02	.15	66
Talamanca	.0	10.8	47.4	38.4	3.4	.29	1.97	.84	8.94	.49	6.47	.14	47
Olivia	.0	20.2	21.2	53.4	5.2	.35	2.29	1.45	9.12	.65	7.86	.15	62
Farm 4	.0	7.7	8.8	79.0	4.5	.35	1.72	1.68	10.02	.27	7.15	.11	59
Farm 8	.0	13.5	14.5	65.5	6.5	.40	1.98	1.13	10.11	.33	11.45	.19	62
Farm 2	.0	21.6	21.6	50.9	5.9	.35	1.75	1.34	8.81	.27	7.32	.16	59
Farm 8	.0	13.6	24.6	57.1	4.7	.52	1.20	.85	8.64	.33	8.36	.11	62
Farm 8	.0	11.3	13.1	70.2	5.4	.31	1.61	1.30	6.37	.27	8.43	.10	62
Whole Division	.0.5	13.9	24.9	55.9	4.8	.37	1.73	1.08	8.93	.31	7.85	.14	58

AVERAGE OF RESULTS BY DISTRICTS

Changuinola	.0	13.5	16.6	64.5	5.4	.38	1.65	1.26	8.79	.29	8.54	.13	61
Sixaola	.0	15.1	24.9	54.5	5.5	.38	1.72	1.03	9.02	.25	8.47	.14	62
Talamanca	.1.5	12.9	33.3	48.8	3.5	.34	1.82	.94	9.09	.39	6.55	.14	51
Upland	.0.1	14.2	28.4	52.1	5.2	.37	1.64	.98	9.10	.29	8.04	.14	60
Silt Deposits	.0.9	13.6	21.4	59.7	4.4	.37	1.82	1.18	8.76	.33	7.66	.14	56

Ratio of Lime to Magnesia

1–1 to 5–1 regarded as normal

100. Chase
4.0–1
2.0–1
1.0–1

101. Chase
1.0–1
.5–1
.5–1

102. Paraiso
1.0–1
3.0–1
1.0–1

103. La Celia
2.0–1
1.0–1
7.0–1

104. Isla Grande
3.0–1
1.0–1
3.0–1

105. La Celia
2.0–1
2.0–1
1.0–1

106. Daytonia
1.0–1
3.0–1
1.0–1

107. Costa Rica
1.0–1
8.0–1
2.0–1

108. Costa Rica
2.0–1
1.0–1
1.0–1

109. Jose
1.0–1
2.0–1
4.0–1

110. Drury
1.0–1
1.0–1
1.0–1

111. Margarita
2.0–1
1.0–1
2.0–1

112. Margarita
6.0–1
2.0–1
3.0–1

113. Catarina
2.0–1
4.0–1
3.0–1

114. Nievecito
1.0–1
5.0–1
1.0–1

115. Riverside
1.0–1
1.0–1
1.0–1

116. Riverside
4.0–1
2.0–1
2.0–1

117. Barranco
4.0–1
8.0–1
1.0–1

118. Elena
1.0–1
1.0–1
1.0–1

119. Senosri
1.0–1
1.0–1
5.0–1

120. Sibubi
10.0–1
2.0–1
2.0–1

121. Sibubi
1.0–1
4.0–1
1.0–1

122. Dos Canos
6.0–1
2.0–1
4.0–1

123. Favorita
1.0–1
4.0–1
2.0–1

124. Talamanca
6.0–1
2.0–1
8.0–1

125. Talamanca
2.0–1
4.0–1
1.0–1

126. Talamanca
2.0–1
3.0–1
2.0–1

127. Talamanca
4.0–1
1.0–1
1.0–1

128. Talamanca
4.0–1
1.0–1
1.0–1

129. Talamanca
1.0–1
2.0–1
1.0–1

130. Talamanca
2.0–1
1.0–1
6.0–1

131. Talamanca
1.0–1
4.0–1
.5–1

132. Talamanca
6.0–1
1.0–1
1.0–1

133. Talamanca
1.0–1
2.0–1
6.0–1

134. Olivia
2.0–1
2.0–1
1.0–1

135. Farm 4
1.0–1
1.0–1
1.0–1

136. Farm 8
1.0–1
3.0–1
2.0–1

137. Farm 2
1.0–1
2.0–1
1.0–1

138. Farm 8
3.0–1
1.0–1
1.0–1

139. Farm 8
2.0–1
2.0–1
1.0–1

Ratio of Organic Matter to Nitrogen

30–1 to 40–1 regarded as normal

100. Chase
40–1
44–1
50–1

101. Chase
27–1
835–1
56–1

102. Paraiso
36–1
56–1
92–1

103. La Celia
50–1
100–1
24–1

104. Isla Grande
48–1
53–1
48–1

105. La Celia
30–1
40–1
72–1

106. Daytonia
40–1
55–1
49–1

107. Costa Rica
30–1
65–1
58–1

108. Costa Rica
56–1
47–1
900–1

109. Jose
32–1
63–1
80–1

110. Drury
96–1
48–1
52–1

111. Margarita
50–1
40–1
70–1

112. Margarita
48–1
70–1
44–1

113. Catarina
40–1
35–1
63–1

114. Nievecito
440–1
75–1
947–1

115. Riverside
43–1
63–1
60–1

116. Riverside
33–1
1070–1
63–1

117. Barranco
40–1
40–1
36–1

118. Elena
49–1
54–1
53–1

119. Senosri
49–1
80–1
150–1

120. Sibubi
36–1
80–1
110–1

121. Sibubi
43–1
3300–1
rocks

122. Dos Canos
24–1
48–1
95–1

123. Favorita
63–1
56–1
40–1

124. Talamanca
40–1
50–1
60–1

125. Talamanca
36–1
653–1
56–1

126. Talamanca
30–1
56–1
72–1

127. Talamanca
64–1
34–1
35–1

128. Talamanca
36–1
42–1
12–1

129. Talamanca
26–1
30–1
32–1

130. Talamanca
24–1
63–1
110–1

131. Talamanca
30–1
36–1
70–1

132. Talamanca
28–1
400–1
108–1

133. Talamanca
24–1
50–1
100–1

134. Olivia
33–1
65–1
56–1

135. Farm 4
64–1
46–1
96–1

136. Farm 8
30–1
96–1
85–1

137. Farm 2
28–1
50–1
50–1

138. Farm 8
77–1
63–1
150–1

139. Farm 8
42–1
45–1
2200–1

Examination of Individual Farms

Chase 35–38. This particular sample is from a very hard and refractory spot where conditions have been only fair. The effect of mulching is evident and generally indicates an increasing production. The chemical examination is good.

Chase 43. Conditions somewhat similar to those in the previous sample except the soil is light and easily worked. Analysis not quite so good as in the earlier sample.

Paraiso. A fairly satisfactory analysis. Phosphoric acid is low when taken in connection with the iron content.

La Celia 54. Organic matter and total nitrogen are low, lime satisfactory, phosphoric acid also satisfactory.

Isla Grande. An area with a good record and a fair analysis. Organic matter and nitrogen are rather low and iron fairly high.

La Celia 39. A light soil of fair depth and giving a fairly good analysis. Phosphoric acid low and iron high.

Daytonia. A satisfactory analysis.

Costa Rica 14. A soil of good depth, shows high organic matter in the top portion and high iron.

Costa Rica 15. The analysis is satisfactory except for the low nitrogen; iron is rather high.

Jose. This area was ruined by hurricane, after which production was poor. It shows high organic matter and nitrogen, and aside from high iron the analysis is satisfactory. It is, however, a hard and heavily worked soil.

Drury. Also ruined by hurricane in 1912. Very high in iron, high organic matter.

Margarita 9. An area with an excellent record and a satisfactory analysis. Total nitrogen rather low.

Margarita 8. Rather low in organic matter. The potash is considerably below the average for the Division, but is still adequate.

Catarina. An area with excellent record and good analysis.

Nievecito 51. This is a new farm which had no record of production at the time sample was taken. It is high in iron, low in lime and very low in total nitrogen, but high in organic matter.

Riverside 21–34. Analysis satisfactory except for deficiency in phosphoric acid. Organic matter rather low.

Riverside 7. Area newly cleared land. Analysis satisfactory except that nitrogen is somewhat low.

Barranco. Analysis satisfactory. Potash below average.

Elena. Area with good record. Potash low and total nitrogen below average.

Senosri. Organic matter and nitrogen both very low, otherwise analysis is good.

Sibubi 48. An area with poor production. The soil is hard and refractory, although the analysis is fairly satisfactory.

Sibubi 93. Also hard and refractory soil which has yielded poorly. Total nitrogen extremely low, in fact the lowest in the Division.

Dos Canos. A soil with good depth and excellent record; analysis satisfactory.

Favorita. An area with excellent result for six years, a good depth and satisfactory analysis.

Talamanca 1. This and the succeeding Talamanca soils are of virgin woodland. Like most tropical forest lands, the analysis shows low organic matter and nitrogen, otherwise satisfactory.

Talamanca 2. Soil high in potash and lime, but low in total nitrogen.

Talamanca 3. Satisfactory analysis.

Talamanca 4. Very low in organic matter, low in nitrogen and considerably below average in potash.

Talamanca 5. Excellent analysis except for low organic matter.

Talamanca 6. Same as above.

Talamanca 7. Rather low in potash, very rich in phosphoric acid.

Talamanca 8. Satisfactory as a forest soil.

Talamanca 9. Deficient in lime, high in iron; phosphoric acid only half normal for the Division.

Talamanca 10. Rather low in organic matter, otherwise satisfactory.

Olivia. Area with good record, soil of good depth and satisfactory analysis, high in phosphoric acid.

Changuinola, Farm 4. Area which has had poor production and rapid spread of disease. A soil of fair depth, low in total nitrogen and high in iron.

Changuinola, Farm 8–20F. Area with a good record, good depth and satisfactory analysis.

Changuinola, Farm 2. Area with an excellent record and good analysis.

Changuinola, Farm 8–67. Area with a poor record, soil rather thin, high in iron at the surface and rather low in total nitrogen.

Changuinola, Farm 8. Area with good record, low in total nitrogen, otherwise satisfactory.

Tabular View of Soil Conditions

Explanation of Abbreviations

Potash— h = greater than .30%
l = less than .15%

Lime— h = greater than 2%
l = less than 1%

Organic Matter— h = greater than 15%
l = less than 9%

Nitrogen— h = greater than .30%
l = less than .15%

Phosphoric Acid— h = greater than .30%
l = less than .15%

h = high m = medium r = rapid * = hard, refractory soil
l = low v = very s = slow

Farm	*History*	*Depth*	*Potash*	*Lime*	*Organic Matter*	*Nitrogen*	*Phosphoric Acid*	*Disease Spread*
*Chase	fair	very good	h	m	ml	m	h	s
Chase	fair	good	m	l	ml	m	h	s
Paraiso	excellent	good	h	m	m	m	l	s–r
La Celia	excellent	good	m	h	l	l	m	s–r
Isla Grande	good	good	h	h	l	l	m	s
La Celia	excellent	thin	m–h	h	l	m	m	s–r
Daytonia	good	good	h	m–h	l	m	m	s
Costa Rica	fair	good	h	m	m	m	m–h	s–r
Costa Rica	good	good	h	h	l	l	h	r
*Jose	good	good	h	m–h	m	m	m	r
Drury	good–bad	good	m–h	m	h	m	m	s–r
Margarita	excellent	good	h	h	ml	l	m	s–r
Margarita	excellent–bad	good	m	h	l	m	m	s–r
Catarina	excellent	good	h	h	m	m	h	s

Nievecito	–	good	m	l	m	vl	m	r
Riverside	excellent	good	h	h	l	m	l	s–r
Riverside	–	good	h	m	m	ml	m	
Barranco	excellent	good	m	m	m	m	h	s
Elena	good–bad	good	m	m	l	l	m	s–r
Senosri	fair	fair–good	h	h	l	vl	h	s
*Sibubi	poor	fair–good	h	m	m	m	l	r
*Sibubi	poor	fair	h	m	ml	vl	m	s
Dos Canos	good	good	h	m	m	mh	m	s–r
Favorita	excellent	good	h	m	m–l	m	m	s–r
Talamanca	–	fair–good	h	h	l	l	h	
Talamanca	–	good	h	h	l	l	m	
Talamanca	–	good	h	h	l	m	h	
Talamanca	–	good	m	m	vl	l	h	
Talamanca	–	good	h	m	vl	ml	h	
Talamanca	–	good	h	m	l	m	m	
Talamanca	–	good	h	m	l	m	h	
Talamanca	–	good	h	m	l	m	h	
Talamanca	–	good	m	l	m	m	m	
Talamanca	–	good	m–h	h	l	m–l	h	
Olivia	good	good	h	h	l	m	h	s
Farm 4	poor	fair	h	m	l	l	m	v r
Farm 8	good	good	h	m	m	m	h	s
Farm 2	good	good	h	m	l	m	m–h	v s
Farm 8	poor	fair	h	m–l	ml	l	h	r
Farm 8	good	good	h	m	ml	l	m	s

From this table it will appear that the Division is high in potash, medium to high in lime, rather low in organic matter and nitrogen, and medium to low in phosphoric acid, except in the virgin forest samples in Talamanca. In practically all these the phosphoric acid is high, as is also the potash, but the organic matter and nitrogen are lower than in the cultivated farms. It will be observed that there is no definite correlation between the rate of spread of the disease and any of the chemical factors. In the Division as a whole, however, the spread of disease has been relatively slow, and, in my opinion, where it has changed from slow to rapid it has been as a result of flooding, storm or some other wholesale disturbance whereby the infection could be greatly increased.

GUATEMALA DIVISION

The Guatemala Division consists very largely of alluvial lands lying along the Motagua Valley. The older farms lie away from this valley and are not so distinctly alluvial but more hillside and upland land. Geologically, Guatemala is very much mixed up, consisting in part of old granite, diorite schists, and gneiss with very little lava, except in a few locations. The river valley farms are made up very largely of these decomposed rocks which have been laid down as a result of flooding, and the whole division is very high in silt and clay. As a matter of fact, in but one of the samples examined has gravel been found, and but three of the samples gave sand of sufficient size to be graded as "coarse." According to the scheme of mechanical analysis 96.1% of the soils examined are made up of silt and clay. The highest percentage of sand is found in Toltec Farm, which shows 30.6% of fine and coarse sand, of which 30.4% is fine sand. The highest silt is found in Sacramento with a percentage of 99.1 and the highest clay in Pequot with a

percentage of 7.7. The percentage of iron in the Division is about the average for soils in general, running slightly less than 5. The highest iron was found in Chickasaw Farm with a percentage of 11.59 and the lowest in one of the Oneida samples with a percentage of 1.53. Lime and magnesia are found in approximately equal amounts in the whole Division, there being but a few instances of a much higher percentage of lime than magnesia and a few instances in which the reverse is the case. The average percentage of lime in the Division is .61, which is to be regarded as much lower than desirable. The percentage of magnesia is .63, which is satisfactory. The Division may be classed then as somewhat deficient in lime. The distribution of potash is fairly even; the highest result found was in one of the samples from Quiche, and strikingly, the lowest result is another sample from the same farm. In general it is noted that the surface layers of the soil contain fairly good percentages of this element. In a few instances there is apparently a deficiency in the surface layers.

The effect of silt deposition. The effect of silt deposition has been considered in the examination of these samples. Of the seven samples in which marked silt deposition takes place, six have had an excellent cultivation history. Of twenty-three samples in which no silt deposition is reported, thirteen have a good cultivation history. One other point is observed in this connection which is, that in practically every instance where the cultivation history has been satisfactory, the soil has been relatively light and easily worked. The few exceptions to this are seen in samples numbered 205, 226, 227 and 228, where a good cultivation history is accompanied by a statement of a hard and refractory or stiff soil. In 226, 227 and 228 there are, however, records of bad disease conditions in the farm.

GUATEMALA DIVISION

SERIAL NUMBER *201*

Location: *Pequot* Farm, Section *69*. Date: *September, 1916.*

Other distinguishing features: *Back of camps.* Collector: *L. W. W.*

NATURAL FEATURES

Topography: *Hillside.*
Drainage: *Good, natural.*
Flood conditions: *None.*
Silt deposition: *None.*
Type of forest growth: *Heavy.*

CULTIVATION HISTORY

When cleared and planted: *1908.*
Number of replantings: *None.* Why? *Abandoned for disease 1916.*
General condition when in production: *Fair.*
Plowed? *No.* When? Grubbed? *No.* When?
Years in bananas: *Seven.* Life of farm: *Abandoned.*
Years in bush or fallow: *One.*
Other crops grown: *None.*

DISEASE HISTORY

When first noted: *1911 or earlier.*
Age of plants when attacked: *About three years.*
Rapidity of spread: *Medium.*
Treatment given: *Digging out and bleaching.*

OTHER DATA

First appearance of Panama Disease in Division.

	Surface—6"	6"—18"	18"—30"
Physical Examination			
Color	red brown	red brown	red brown
Compactness	hard	hard	hard
Friability	refractory	refractory	refractory
Retentive power	72	60	61
Mechanical Examination			
Coarse gravel	0	0	0
Fine gravel	0	0	0
Coarse sand	0	0	0
Fine sand	0	0	0
Silt	94.5	87.1	96.5
Clay	5.5	12.9	3.5
Chemical Examination			
Organic matter	7.83	5.70	5.58
Total Nitrogen	.28	.17	.13
Potash (K_2O)	.26	.47	.97
Phosphoric acid (P_2O_5)	.08	.11	.41
Lime (CaO)	.13	.15	.11
Magnesia (MgO)	.16	.22	.35
Iron (Fe_2O_3)	2.88	7.23	4.38
Alumina (Al_2O_3)			
Silica, sol. (SiO_2)			
Free Acidity			
Mycological Examination			
Typical Fusaria	Panama Disease present in farm		
Other Fusaria			

GUATEMALA DIVISION

SERIAL NUMBER *202*

Location: *Dartmouth* Farm, Section *32*. Date: *September, 1916.*

Other distinguishing features: *Close to railroad near commissary.* Collector: *L. W. W.*

NATURAL FEATURES

Topography: *Bottom land.*
Drainage: *Good, open ditches.*
Flood conditions: *None.*
Silt deposition: *None.*
Type of forest growth: *Heavy.*

CULTIVATION HISTORY

When cleared and planted: *About 1908.*
Number of replantings: *None, except by supplying.* Why?
General condition when in production: *Good.*
Plowed? *No.* When? Grubbed? *No.* When?
Years in bananas: *Eight.* Life of farm: *Still producing well.*
Years in bush or fallow: *Never.*
Other crops grown: *None.*

DISEASE HISTORY

When first noted: *November, 1916, in rear of section.*
Age of plants when attacked: *Eight years.*
Rapidity of spread: *Slow.*
Treatment given: *Digging out and bleaching.*

OTHER DATA

Very few cases of Panama Disease in this farm, entirely limited to hill land near woodland.

	Surface—6"	6"—18"	18"—30"
Physical Examination			
Color	brown	brown	light brown
Compactness	loose	light	loose
Friability	light	loose	light
Retentive power	90	84	87
Mechanical Examination			
Coarse gravel	0	0	0
Fine gravel	0	0	0
Coarse sand	0	0	0
Fine sand	0	0	0
Silt	91.5	95.4	95.3
Clay	8.5	4.6	4.7
Chemical Examination			
Organic matter	1.09	7.78	8.28
Total Nitrogen	.41	.10	.19
Potash (K_2O)	.17	.32	.27
Phosphoric acid (P_2O_5)	.21	.19	.17
Lime (CaO)	1.53	1.03	1.14
Magnesia (MgO)	.49	.50	.29
Iron (Fe_2O_3)	5.43	5.70	5.47
Alumina (Al_2O_3)			
Silica, sol. (SiO_2)			
Free Acidity			
Mycological Examination			
Typical Fusaria	Panama Disease present in farm		
Other Fusaria			

GUATEMALA DIVISION

SERIAL NUMBER *203*

Location: *Oneida* Farm, Section ; *Near woodland.* Date: *September, 1916.*
Other distinguishing features: Collector: *L. W. W.*

NATURAL FEATURES
Topography: *Upland.*
Drainage: *Good, natural.*
Flood conditions: *None.*
Silt deposition: *None.*
Type of forest growth: *Heavy.*

CULTIVATION HISTORY
When cleared and planted: *1911.*
Number of replantings: *None, except by supplying.* Why?
General condition when in production: *Good.*
Plowed? *No.* When? Grubbed? *No.* When?
Years in bananas: *Six.* Life of farm: *Still good.*
Years in bush or fallow: *Never.*
Other crops grown: *None.*

DISEASE HISTORY
When first noted: *Panama Disease in 1915, Colorado Disease two years before.*
Age of plants when attacked: *Four years.*
Rapidity of spread: *Slow.*
Treatment given: *Digging out, bleaching and abandoning.*

OTHER DATA
More or less disease throughout section. Small diseased areas were cut down and abandoned. Entire section was allowed to grow to bush, but after six months was cleaned and is now cleaned regularly, except abandoned areas.

	Surface—6″	6″—18″	18″—30″
Physical Examination			
Color	light brown	gray	light gray
Compactness	loose	hard	hard
Friability	light	refractory	refractory
Retentive power	91	77	74
Mechanical Examination			
Coarse gravel	0	0	0
Fine gravel	0	0	0
Coarse sand	0	0	0
Fine sand	0	0	0
Silt	96.4	98.2	98.0
Clay	3.6	1.8	2.0
Chemical Examination			
Organic matter	6.76	5.28	5.63
Total Nitrogen	.34	.16	.07
Potash (K_2O)	.27	.09	.13
Phosphoric acid (P_2O_5)	.14	.05	.02
Lime (CaO)	.75	.24	.20
Magnesia (MgO)	.39	.32	.04
Iron (Fe_2O_3)	1.53	1.43	4.92
Alumina (Al_2O_3)			
Silica, sol. (SiO_2)			
Free Acidity			
Mycological Examination			
Typical Fusaria	Panama Disease present		
Other Fusaria	Colorado Disease present		

GUATEMALA DIVISION

SERIAL NUMBER *204*

Location: *Oneida* Farm, Section *15*. Date: *September, 1916.*

Other distinguishing features: *Ridge near woodland.* Collector: *L. W. W.*

NATURAL FEATURES

Topography: *Upland.*
Drainage: *Good, natural.*
Flood conditions: *None.*
Silt deposition: *None.*
Type of forest growth: *Heavy.*

CULTIVATION HISTORY

When cleared and planted: *1911.*
Number of replantings: *None. Supplying only.* Why?
General condition when in production: *Good.*
Plowed? *No.* When? Grubbed? *No.* When?
Years in bananas: *Six.* Life of farm: *Still good.*
Years in bush or fallow: *Never.*
Other crops grown: *None.*

DISEASE HISTORY

When first noted: *Panama Disease 1915, Colorado Disease 1914.*
Age of plants when attacked: *Four years.*
Rapidity of spread: *Slow.*
Treatment given: *Digging out, bleaching, and abandoning.*

OTHER DATA

Same as 203.

	Surface—6"	6"—18"	18"—30"
Physical Examination			
Color	light brown	gray	light gray
Compactness	loose	hard	hard
Friability	light	refractory	refractory
Retentive power	87	77	69
Mechanical Examination			
Coarse gravel	0	0	0
Fine gravel	0	0	0
Coarse sand	0	0	0
Fine sand	0	0	0
Silt	96.7	98.6	98.5
Clay	3.3	1.4	1.5
Chemical Examination			
Organic matter	10.20	5.74	5.02
Total Nitrogen	.31	.15	.08
Potash (K_2O)	.05	.20	.18
Phosphoric acid (P_2O_5)	.14	.06	.03
Lime (CaO)	.25	.16	.40
Magnesia (MgO)	.31	.55	.13
Iron (Fe_2O_3)	1.95	1.95	.90
Alumina (Al_2O_3)			
Silica, sol. (SiO_2)			
Free Acidity			
Mycological Examination			
Typical Fusaria	Panama Disease present		
Other Fusaria	Colorado Disease present		

GUATEMALA DIVISION

SERIAL NUMBER *205*

Location: *Oneida* Farm, Section *16*. Date: *September, 1916.*

Other distinguishing features: *Talpetate ridge near woods.* Collector: *L. W. W.*

NATURAL FEATURES

Topography: *Upland.*
Drainage: *Good, natural.*
Flood conditions: *None.*
Silt deposition: *None.*
Type of forest growth: *Heavy.*

CULTIVATION HISTORY

When cleared and planted: *1911.*
Number of replantings: *None. Supplying only.* Why?
General condition when in production: *Good.*
Plowed? *No.* When? Grubbed? *No.* When?
Years in bananas: *Six.* Life of farm: *Still good.*
Years in bush or fallow: *Never.*
Other crops grown: *None.*

DISEASE HISTORY

When first noted: *Panama Disease 1915, Colorado Disease two years before.*
Age of plants when attacked: *Four years.*
Rapidity of spread: *Slow.*
Treatment given: *Digging out, bleaching and abandoning.*

OTHER DATA

Same as 203, 204.

	Surface—6"	6"—18"	18"—30"
PHYSICAL EXAMINATION			
Color	dark gray	gray	light gray
Compactness	hard	hard	hard
Friability	refractory	refractory	refractory
Retentive power	68	52	59
MECHANICAL EXAMINATION			
Coarse gravel	0	0	0
Fine gravel	0	0	0
Coarse sand	0	0	0
Fine sand	0	0	0
Silt	97.5	97.8	97.1
Clay	2.5	2.2	2.9
CHEMICAL EXAMINATION			
Organic matter	7.72	5.38	4.71
Total Nitrogen	.23	.08	.06
Potash (K_2O)	.16	.10	.05
Phosphoric acid (P_2O_5)	.12	.06	.04
Lime (CaO)	.27	.04	.06
Magnesia (MgO)	.64	.07	.07
Iron (Fe_2O_3)	8.35	1.32	1.59
Alumina (Al_2O_3)			
Silica, sol. (SiO_2)			
Free Acidity			
MYCOLOGICAL EXAMINATION			
Typical Fusaria	Panama Disease present		
Other Fusaria	Colorado Disease present		

GUATEMALA DIVISION

SERIAL NUMBER *206*

Location: *Virginia* Farm, Section ; *High ridge.* Date: *September, 1916.*

Other distinguishing features: *Opposite camps, Section 81.* Collector: *L. W. W.*

NATURAL FEATURES

Topography: *Upland.*
Drainage: *Good, natural.*
Flood conditions: *None.*
Silt deposition: *None.*
Type of forest growth: *Heavy.*

CULTIVATION HISTORY

When cleared and planted: *1907.*
Number of replantings: *None. Supplying only.* Why?
General condition when in production: *Fair.*
Plowed? *No.* When? Grubbed? *No.* When?
Years in bananas: *Nine.* Life of farm: *Only fair production.*
Years in bush or fallow: *One.*
Other crops grown: *None.*

DISEASE HISTORY

When first noted: *1914.*
Age of plants when attacked: *Seven.*
Rapidity of spread: *Slow.*
Treatment given: *Area abandoned April, 1916, and plants cut down.*

OTHER DATA

Panama Disease is spread throughout the farm.

	Surface—6"	6"—18"	18"—30"
Physical Examination			
Color	light gray	light gray	light gray
Compactness	hard	hard	hard
Friability	refractory	refractory	refractory
Retentive power	57	68	77
Mechanical Examination			
Coarse gravel	0	0	0
Fine gravel	0	0	0
Coarse sand	8.7	0	2.2
Fine sand	51.0	0	24.8
Silt	36.6	96.6	70.1
Clay	3.7	3.4	2.9
Chemical Examination			
Organic matter	6.18	4.27	6.46
Total Nitrogen	.15	.09	.05
Potash (K_2O)	.01	.56	.61
Phosphoric acid (P_2O_5)	.05	.05	.57
Lime (CaO)	.02	.07	.14
Magnesia (MgO)	.42	.05	.14
Iron (Fe_2O_3)	2.99	1.78	2.02
Alumina (Al_2O_3)			
Silica, sol. (SiO_2)			
Free Acidity			
Mycological Examination			
Typical Fusaria	Panama Disease present		
Other Fusaria			

GUATEMALA DIVISION

SERIAL NUMBER *207*

Location: *Cayuga* Farm, Section *28*. Date: *September, 1916.*

Other distinguishing features: *Cayuga Bend.* Collector: *L. W. W.*

NATURAL FEATURES

Topography: *Valley.*
Drainage: *Good, swale, and ditching.*
Flood conditions: *Almost yearly.*
Silt deposition: *Two to four inches.*
Type of forest growth: *Heavy.*

CULTIVATION HISTORY

When cleared and planted: *1907–8.*
Number of replantings: *None. Supplying only.* Why?
General condition when in production: *Good.*
Plowed? *No.* When? Grubbed? *No.* When?
Years in bananas: *Nine.* Life of farm: *Very good, large fruit.*
Years in bush or fallow: *Never.*
Other crops grown: *None.*

DISEASE HISTORY

When first noted: *No Panama Disease, some Colorado Disease in 1911-12.*
Age of plants when attacked: *Four years.*
Rapidity of spread: *Plants have been healthy since 1912.*
Treatment given: *Digging out, burning and liming.*

OTHER DATA

In 1911-12 many plants were suspected of disease and were treated as above. A heavy blow-down followed by a flood occurred soon after and since then there has been no disease.

	Surface—6"	6"—18"	18"—30"
Physical Examination			
Color	light brown	light brown	light brown
Compactness	loose	loose	loose
Friability	light	light	light
Retentive power	96	79	72
Mechanical Examination			
Coarse gravel	0	0	0
Fine gravel	0	0	0
Coarse sand	0	0	0
Fine sand	0	0	0
Silt	96.0	96.0	95.8
Clay	4.0	4.0	4.2
Chemical Examination			
Organic matter	7.76	5.58	3.82
Total Nitrogen	.28	.14	.10
Potash (K_2O)	.51	.35	.47
Phosphoric acid (P_2O_5)	.23	.13	.15
Lime (CaO)	1.06	.78	.94
Magnesia (MgO)	.83	.37	1.65
Iron (Fe_2O_3)	5.65	5.69	5.62
Alumina (Al_2O_3)			
Silica, sol. (SiO_2)			
Free Acidity			
Mycological Examination			
Typical Fusaria	No Panama Disease present		
Other Fusaria	Colorado Disease present		

GUATEMALA DIVISION

SERIAL NUMBER *208*

Location: *Navajo* Farm, Section *11.* Date: *September, 1916.*

Other distinguishing features: *Navajo Bend.* Collector: *L. W. W.*

NATURAL FEATURES

Topography: *Bottom land.*
Drainage: *Good, swale, and open ditches.*
Flood conditions: *Yearly.*
Silt deposition: *Several inches.*
Type of forest growth: *Heavy.*

CULTIVATION HISTORY

When cleared and planted: *1908.*
Number of replantings: *None. Supplying only.* Why?
General condition when in production: *Good.*
Plowed? *No.* When? Grubbed? *No.* When?
Years in bananas: *Nine.* Life of farm: *Good, large fruit.*
Years in bush or fallow: *Never.*
Other crops grown: *None.*

DISEASE HISTORY

When first noted: *None.*
Age of plants when attacked:
Rapidity of spread:
Treatment given:

OTHER DATA

	Surface—6"	6"—18"	18"—30"
Physical Examination			
Color	dark brown	dark brown	brown
Compactness	loose	loose	loose
Friability	light	light	light
Retentive power	93	69	60
Mechanical Examination			
Coarse gravel	0	0	0
Fine gravel	0	0	0
Coarse sand	0	0	0
Fine sand	0	0	0
Silt	94.8	96.5	97.2
Clay	5.2	3.5	2.8
Chemical Examination			
Organic matter	10.68	4.81	4.72
Total Nitrogen	.49	.21	.16
Potash (K_2O)	.34	.27	.36
Phosphoric acid (P_2O_5)	.49	.21	.16
Lime (CaO)	1.25	.89	.82
Magnesia (MgO)	.80	1.11	.70
Iron (Fe_2O_3)	5.51	5.42	5.64
Alumina (Al_2O_3)			
Silica, sol. (SiO_2)			
Free Acidity			
Mycological Examination			
Typical Fusaria	No Panama Disease present		
Other Fusaria			

GUATEMALA DIVISION

SERIAL NUMBER *209*

Location: *Dartmouth* Farm, Section *2*. Date: *September, 1916.*

Other distinguishing features: *River section, near railroad.* Collector: *L. W. W.*

NATURAL FEATURES

Topography: *Bottom land.*
Drainage: *Open drains.*
Flood conditions: *Only in extremely high water.*
Silt deposition: *Very little.*
Type of forest growth: *Heavy.*

CULTIVATION HISTORY

When cleared and planted: *1908.*
Number of replantings: *None. Supplying only.* Why?
General condition when in production: *Good.*
Plowed? *No.* When? Grubbed? *No.* When?
Years in bananas: Nine. Life of farm: *Still producing well.*
Years in bush or fallow: *Never.*
Other crops grown: *None.*

DISEASE HISTORY

When first noted: *None.*
Age of plants when attacked:
Rapidity of spread:
Treatment given:

OTHER DATA

Only one case of Panama Disease was ever reported in river sections of Dartmouth, and that was along railroad on side of railroad ditch. (This may have been Colorado Disease.)

	Surface—6"	6"—18"	18"—30"
Physical Examination			
Color	light brown	light brown	light brown
Compactness	loose	loose	loose
Friability	light	light	light
Retentive power	98	83	62
Mechanical Examination			
Coarse gravel	0	0	0
Fine gravel	0	0	0
Coarse sand	0	0	0
Fine sand	0	0	0
Silt	95.0	97.6	98.0
Clay	5.0	2.4	2.0
Chemical Examination			
Organic matter	13.78	5.58	2.28
Total Nitrogen	.16	.17	.07
Potash (K_2O)	.27	.30	.34
Phosphoric acid (P_2O_5)	.30	.21	.18
Lime (CaO)	1.37	.74	.70
Magnesia (MgO)	1.70	.54	.49
Iron (Fe_2O_3)	5.67	7.18	5.29
Alumina (Al_2O_3)			
Silica, sol. (SiO_2)			
Free Acidity			
Mycological Examination			
Typical Fusaria	No Panama Disease present		
Other Fusaria			

GUATEMALA DIVISION

SERIAL NUMBER *210*

Location: *Navajo* Farm, Section *54*. Date: *September, 1916.*

Other distinguishing features: *Hillside.* Collector: *L. W. W.*

NATURAL FEATURES

Topography: *Hillside.*
Drainage: *Good, natural.*
Flood conditions: *None.*
Silt deposition: *None.*
Type of forest growth: *Heavy.*

CULTIVATION HISTORY

When cleared and planted: *1908.*
Number of replantings: *None. Supplying only.* Why?
General condition when in production: *Fair to bad.*
Plowed? *No.* When? Grubbed? *No.* When?
Years in bananas: *Seven.* Life of farm: *Small production now.*
Years in bush or fallow: *Two years.*
Other crops grown: *None.*

DISEASE HISTORY

When first note: *About 1911.*
Age of plants when attacked: *Three years.*
Rapidity of spread: *Slow.*
Treatment given: *Digging out and liming.*

OTHER DATA

Part of hill area slashed and abandoned in April, 1916. Very little production for a year previous.

	Surface—6"	6"—18"	18"—30"
Physical Examination			
Color	dark brown	light brown	light brown
Compactness	hard	hard	hard
Friability	refractory	refractory	refractory
Retentive power	73	55	57
Mechanical Examination			
Coarse gravel	0	0	0
Fine gravel	0	0	0
Coarse sand	0	0	0
Fine sand	0	0	0
Silt	97.0	98.0	98.5
Clay	3.0	2.0	1.5
Chemical Examination			
Organic matter	12.75	6.88	5.61
Total Nitrogen	.53	.25	.18
Potash (K_2O)	.10	.11	.16
Phosphoric acid (P_2O_5)	.29	.18	.11
Lime (CaO)	1.29	.28	.24
Magnesia (MgO)	.17	.08	.18
Iron (Fe_2O_3)	7.64	2.65	3.17
Alumina (Al_2O_3)			
Silica, sol. (SiO_2)			
Free Acidity			
Mycological Examination			
Typical Fusaria	Panama Disease present		
Other Fusaria			

GUATEMALA DIVISION

SERIAL NUMBER *211*

Location: *York* Farm, Section *16*. Date: *September, 1916.*

Other distinguishing features: *Alongside farm railway.* Collector: *L. W. W.*

NATURAL FEATURES

Topography: *Upland.*
Drainage: *Good, open ditches.*
Flood conditions: *None.*
Silt deposition: *None.*
Type of forest growth: *Heavy.*

CULTIVATION HISTORY

When cleared and planted: *1907.*
Number of replantings: *None. Supplying only.* Why?
General condition when in production: *Poor.*
Plowed? *No.* When? Grubbed? *No.* When?
Years in bananas: *Nine.* Life of farm: *Good for four or five years, fruit now small.*
Years in bush or fallow: *Never.*
Other crops grown: *None.*

DISEASE HISTORY

When first noted: *1911-12.*
Age of plants when attacked: *Four years.*
Rapidity of spread: *Slow.*
Treatment given: *Digging out and liming.*

OTHER DATA

Entire area burned over in May, 1915. Yield since fire has been poor, and section is to be abandoned.

	Surface—6″	6″—18″	18″—30″
Physical Examination			
Color	light gray	light gray	light gray
Compactness	hard	hard	hard
Friability	refractory	refractory	refractory
Retentive power	53	53	61
Mechanical Examination			
Coarse gravel	0	0	0
Fine gravel	0	0	0
Coarse sand	0	0	0
Fine sand	0	0	0
Silt	98.2	98.3	98.6
Clay	1.8	1.7	1.4
Chemical Examination			
Organic matter	6.74	2.63	5.03
Total Nitrogen	.15	.08	.06
Potash (K_2O)	.12	.13	.13
Phosphoric acid (P_2O_5)	.04	.05	.04
Lime (CaO)	.07	.11	.09
Magnesia (MgO)	.08	.05	.25
Iron (Fe_2O_3)	2.16	2.20	2.46
Alumina (Al_2O_3)			
Silica, sol. (SiO_2)			
Free Acidity			
Mycological Examination			
Typical Fusaria	Panama Disease present		
Other Fusaria			

GUATEMALA DIVISION

SERIAL NUMBER *212*

Location: *York* Farm, Section *13*. Date: *September, 1916.*

Other distinguishing features: *Abandoned land by railroad.* Collector: *L. W. W.*

NATURAL FEATURES

Topography: *Upland.*
Drainage: *Open drains.*
Flood conditions: *None.*
Silt deposition: *None.*
Type of forest growth: *Heavy.*

CULTIVATION HISTORY

When cleared and planted: *1907.*
Number of replantings: *None. Supplying only.* Why?
General condition when in production: *Fair for a few years, later poor.*
Plowed? *No.* When? Grubbed? *No.* When?
Years in bananas: *Nine.* Life of farm: *Abandoned May, 1915.*
Years in bush or fallow: *One.*
Other crops grown: *None.*

DISEASE HISTORY

When first noted: *1911-12.*
Age of plants when attacked: *Four years.*
Rapidity of spread: *Slow.*
Treatment given: *Digging out and liming.*

OTHER DATA

Same as 211.

	Surface—6"	6"—18"	18"—30"
Physical Examination			
Color	gray	gray	gray
Compactness	hard	hard	hard
Friability	refractory	refractory	refractory
Retentive power	65	65	67
Mechanical Examination			
Coarse gravel	0	0	0
Fine gravel	0	0	0
Coarse sand	0	0	0
Fine sand	0	0	21.8
Silt	97.7	98.1	76.4
Clay	2.3	1.9	1.8
Chemical Examination			
Organic matter	8.31	3.94	6.68
Total Nitrogen	.24	.12	.10
Potash (K_2O)	.12	.19	.10
Phosphoric acid (P_2O_5)	.03	.29	.04
Lime (CaO)	.24	.55	.12
Magnesia (MgO)	.03	.08	.20
Iron (Fe_2O_3)	3.21	2.10	2.11
Alumina (Al_2O_3)			
Silica, sol. (SiO_2)			
Free Acidity			
Mycological Examination			
Typical Fusaria	Panama Disease present		
Other Fusaria			

GUATEMALA DIVISION

SERIAL NUMBER *213*

Location: *Toltec* Farm, Section *57*.

Date: *September, 1916.*

Other distinguishing features: *Back of hospital.*

Collector: *L. W. W.*

NATURAL FEATURES

Topography: *Hillside.*
Drainage: *Natural.*
Flood conditions: *None.*
Silt deposition: *None.*
Type of forest growth: *Heavy.*

CULTIVATION HISTORY

When cleared and planted: *1910.*
Number of replantings: *None. Supplying only.* Why?
General condition when in production: *Fair.*
Plowed? *No.* When? Grubbed? *No.* When?
Years in bananas: *Six.* Life of farm: *Abandoned 1916, disease.*
Years in bush or fallow: *Seven months.*
Other crops grown: *None.*

DISEASE HISTORY

When first noted: *April, 1916.*
Age of plants when attacked: *Six years.*
Rapidity of spread: *Medium.*
Treatment given: *Digging out and bleaching.*

OTHER DATA

This was one of the first spots where Panama Disease appeared in Quirigua District.

	Surface—6″	6″—18″	18″—30″
Physical Examination			
Color	dark brown	dark brown	dark brown
Compactness	hard	hard	hard
Friability	refractory	refractory	refractory
Retentive power	63	52	41
Mechanical Examination			
Coarse gravel	0	0	0
Fine gravel	0	0	0
Coarse sand	1.0	0	0
Fine sand	24.1	35.8	28.3
Silt	73.8	63.4	71.2
Clay	1.1	0.8	0.5
Chemical Examination			
Organic matter	5.82	3.79	2.67
Total Nitrogen	.17	.07	.05
Potash (K_2O)	.21	.19	.26
Phosphoric acid (P_2O_5)	.16	.09	.05
Lime (CaO)	.24	.18	.81
Magnesia (MgO)	.12	.26	.22
Iron (Fe_2O_3)	1.85	1.93	1.49
Alumina (Al_2O_3)			
Silica, sol. (SiO_2)			
Free Acidity			
Mycological Examination			
Typical Fusaria	Panama Disease present		
Other Fusaria			

GUATEMALA DIVISION

SERIAL NUMBER *214*

Location: *Quirigua* Farm, Section *114*.

Date: *September, 1916.*

Collector: *L. W. W.*

Other distinguishing features:

NATURAL FEATURES

Topography: *Bottom land.*
Drainage: *Natural, good.*
Flood conditions: *About three times a year.*
Silt deposition: *Six inches yearly.*
Type of forest growth: *Heavy.*

CULTIVATION HISTORY

When cleared and planted: *1911.*
Number of replantings: *None. Supplying only.* Why?
General condition when in production: *Good.*
Plowed? *No.* When? Grubbed? *No.* When?
Years in bananas: *Six.* Life of farm: *Still producing well.*
Years in bush or fallow: *Never.*
Other crops grown: *None.*

DISEASE HISTORY

When first noted: *None.*
Age of plants when attacked:
Rapidity of spread:
Treatment given:

OTHER DATA

No disease has ever appeared in this section.

	Surface—6"	6"—18"	18"—30"
Physical Examination			
Color	brown	brown	brown
Compactness	loose	loose	loose
Friability	light	light	light
Retentive power	60	63	61
Mechanical Examination			
Coarse gravel	0	0	0
Fine gravel	0	0	0
Coarse sand	0	0	0
Fine sand	0	0	0
Silt	98.7	98.5	99.1
Clay	1.3	1.5	.9
Chemical Examination			
Organic matter	5.11	5.62	3.94
Total Nitrogen	.13	.18	.08
Potash (K_2O)	.25	.44	.38
Phosphoric acid (P_2O_5)	.15	.15	.16
Lime (CaO)	.85	.94	.85
Magnesia (MgO)	.66	.80	.77
Iron (Fe_2O_3)	4.86	4.63	4.48
Alumina (Al_2O_3)			
Silica, sol. (SiO_2)			
Free Acidity			
Mycological Examination			
Typical Fusaria	No Panama Disease present		
Other Fusaria			

GUATEMALA DIVISION

SERIAL NUMBER *215*

Location: *Aztec* Farm, Section *29*.

Date: *September, 1916.*

Other distinguishing features: *End of tram, near river.*

Collector: *L. W. W.*

NATURAL FEATURES

Topography: *Bottom land.*
Drainage: *Natural, good.*
Flood conditions: *About three times a year.*
Silt deposition: *About six inches yearly.*
Type of forest growth: *Heavy.*

CULTIVATION HISTORY

When cleared and planted: *1911.*
Number of replantings: *None. Supplying only.* Why?
General condition when in production: *Good.*
Plowed? *No.* When? Grubbed? *No.* When?
Years in bananas: *Six.* Life of farm: *Still producing well.*
Years in bush or fallow: *Never.*
Other crops grown: *None.*

DISEASE HISTORY

When first noted: *None.*
Age of plants when attacked:
Rapidity of spread:
Treatment given:

OTHER DATA

No disease has ever appeared in this section.

	Surface—6"	6"—18"	18"—30"
Physical Examination			
Color	brown	brown	brown
Compactness	loose	loose	loose
Friability	light	light	light
Retentive power	87	66	55
Mechanical Examination			
Coarse gravel	0	0	0
Fine gravel	0	0	0
Coarse sand	0	0	0
Fine sand	0	10.6	0
Silt	96.7	87.4	97.6
Clay	3.3	2.0	2.4
Chemical Examination			
Organic matter	4.74	3.11	3.40
Total Nitrogen	.12	.07	.08
Potash (K_2O)	.32	.34	.15
Phosphoric acid (P_2O_5)	.16	.25	.19
Lime (CaO)	.37	.88	.79
Magnesia (MgO)	.21	.58	.11
Iron (Fe_2O_3)	4.73	5.26	4.03
Alumina (Al_2O_3)			
Silica, sol. (SiO_2)			
Free Acidity			
Mycological Examination			
Typical Fusaria	No Panama Disease present		
Other Fusaria			

GUATEMALA DIVISION

SERIAL NUMBER *216*

Location: *Nahua* Farm, Section *; Opposite camps.* Date: *September, 1916.*

Other distinguishing features: Collector: *L. W. W.*

NATURAL FEATURES

Topography: *Bottom land.*
Drainage: *Artificial, open ditches.*
Flood conditions: *About three times a year.*
Silt deposition: *None.*
Type of forest growth: *Heavy.*

CULTIVATION HISTORY

When cleared and planted: *1912.*
Number of replantings: *None. Supplying only.* Why?
General condition when in production: *Fair.*
Plowed? *No.* When? Grubbed? *No.* When?
Years in bananas: *Five.* Life of farm: *Only giving fair production.*
Years in bush or fallow: *Never.*
Other crops grown: *None.*

DISEASE HISTORY

When first noted: *None.*
Age of plants when attacked:
Rapidity of spread:
Treatment given:

OTHER DATA

No disease has ever appeared in this section.

	Surface—6"	6"—18"	18"—30"
Physical Examination			
Color	light brown	light brown	light brown
Compactness	loose	loose	loose
Friability	light	light	light
Retentive power	79	49	41
Mechanical Examination			
Coarse gravel	0	0	0
Fine gravel	0	0	0
Coarse sand	0	0	0
Fine sand	0	0	0
Silt	92.4	99.5	94.2
Clay	7.6	0.5	5.8
Chemical Examination			
Organic matter	18.65	5.31	6.05
Total Nitrogen	.59	.20	.16
Potash (K_2O)	.20	.41	.33
Phosphoric acid (P_2O_5)	.27	.22	.20
Lime (CaO)	.14	.85	.96
Magnesia (MgO)	0	.46	.69
Iron (Fe_2O_3)	6.71	6.13	6.44
Alumina (Al_2O_3)			
Silica, sol. (SiO_2)			
Free Acidity			
Mycological Examination			
Typical Fusaria	No Panama Disease present		
Other Fusaria			

GUATEMALA DIVISION

SERIAL NUMBER *217*

Location: *Puebla* Farm, Section *27; Trackside.*

Date: *September, 1916.*

Collector: *L. W. W.*

Other distinguishing features:

NATURAL FEATURES

Topography: *Bottom land.*
Drainage: *Open ditches.*
Flood conditions: *About three times a year.*
Silt deposition: *None.*
Type of forest growth: *Heavy.*

CULTIVATION HISTORY

When cleared and planted: *1912.*
Number of replantings: *None. Supplying only.* Why?
General condition when in production: *Fair.*
Plowed? *No.* When? Grubbed? *No.* When?
Years in bananas: *Five.* Life of farm: *Still fair production.*
Years in bush or fallow: *Never.*
Other crops grown: *None.*

DISEASE HISTORY

When first noted: *None.*
Age of plants when attacked:
Rapidity of spread:
Treatment given:

OTHER DATA

No disease in this section. (*Neighboring section has had cases.*)

	Surface—6"	6"—18"	18"—30"
Physical Examination			
Color	light brown	light brown	light brown
Compactness	loose	loose	loose
Friability	light	light	light
Retentive power	81	59	70
Mechanical Examination			
Coarse gravel	0	0	0
Fine gravel	0	0	0
Coarse sand	0	0	0
Fine sand	0	0	0.7
Silt	94.3	94.7	94.3
Clay	5.7	5.3	5.0
Chemical Examination			
Organic matter	12.08	5.83	2.48
Total Nitrogen	.33	.14	.11
Potash (K_2O)	.08	.37	.57
Phosphoric acid (P_2O_5)	.24	.15	.15
Lime (CaO)	1.24	.64	.71
Magnesia (MgO)	1.60	.10	1.14
Iron (Fe_2O_3)	5.58	5.76	5.56
Alumina (Al_2O_3)			
Silica, sol. (SiO_2)			
Free Acidity			
Mycological Examination			
Typical Fusaria	No Panama Disease present		
Other Fusaria			

GUATEMALA DIVISION

SERIAL NUMBER *218*

Location: *Tehuana* Farm, Section *25*. Date: *September, 1916.*

Other distinguishing features: *Near Jubuco River close to track.* Collector: *L. W. W.*

NATURAL FEATURES

Topography: *Bottom land.*
Drainage: *Natural, good.*
Flood conditions: *About once a year.*
Silt deposition: *None.*
Type of forest growth: *Heavy.*

CULTIVATION HISTORY

When cleared and planted: *1912.*
Number of replantings: *None. Supplying only.* Why?
General condition when in production: *Good.*
Plowed? *No.* When? Grubbed? *No.* When?
Years in bananas: *Five.* Life of farm: *Production still good.*
Years in bush or fallow: *Never.*
Other crops grown: *None.*

DISEASE HISTORY

Other crops grown: *None.*
Age of plants when attacked:
Rapidity of spread:
Treatment given:

OTHER DATA

No disease has ever appeared in this section.

	Surface—6"	6"—18"	18"—30"
Physical Examination			
Color	light brown	light brown	light brown
Compactness	loose	loose	loose
Friability	light	light	light
Retentive power	93	77	77
Mechanical Examination			
Coarse gravel	0	0	0
Fine gravel	0	0	0
Coarse sand	0	0	0
Fine sand	0	0	0
Silt	94.8	95.5	97.1
Clay	5.2	4.5	2.9
Chemical Examination			
Organic matter	8.38	4.17	3.05
Total Nitrogen	.28	.14	.07
Potash (K_2O)	.31	.40	.34
Phosphoric acid (P_2O_5)	.23	.13	.14
Lime (CaO)	.74	.71	.85
Magnesia (MgO)	.18	.36	1.11
Iron (Fe_2O_3)	6.53	5.02	4.91
Alumina (Al_2O_3)			
Silica, sol. (SiO_2)			
Free Acidity			
Mycological Examination			
Typical Fusaria	No Panama Disease present		
Other Fusaria			

GUATEMALA DIVISION

SERIAL NUMBER *219*

Location: *Quiche* Farm, Section *26*.

Date: *September, 1916.*

Other distinguishing features: *On railroad near camps.*

Collector: *L. W. W.*

NATURAL FEATURES

Topography: *Bottom land.*
Drainage: *Natural, good.*
Flood conditions: *None.*
Silt deposition: *None.*
Type of forest growth: *Heavy.*

CULTIVATION HISTORY

When cleared and planted: *1913.*
Number of replantings: *None. Supplying only.* Why?
General condition when in production: *Fair.*
Plowed? *No.* When? Grubbed? *No.* When?
Years in bananas: *Four.* Life of farm: *Only fair prospects.*
Years in bush or fallow: *Never.*
Other crops grown: *None.*

DISEASE HISTORY

When first noted: *None.*
Age of plants when attacked:
Rapidity of spread:
Treatment given:

OTHER DATA

No disease has ever appeared in this section.

	Surface—6"	6"—18"	18"—30"
Physical Examination			
Color	light brown	light brown	light brown
Compactness	loose	loose	loose
Friability	light	light	light
Retentive power	63	42	38
Mechanical Examination			
Coarse gravel	0	0	0
Fine gravel	0	0	0
Coarse sand	0	0	0
Fine sand	0	0	28.5
Silt	97.1	97.8	70.2
Clay	2.9	2.2	1.3
Chemical Examination			
Organic matter	7.11	3.87	1.52
Total Nitrogen	.20	.08	.06
Potash (K_2O)	.53	.93	.42
Phosphoric acid (P_2O_5)	.15	.46	.14
Lime (CaO)	1.03	.76	.82
Magnesia (MgO)	1.49	.70	.61
Iron (Fe_2O_3)	5.27	4.40	2.43
Alumina (Al_2O_3)			
Silica, sol. (SiO_2)			
Free Acidity			
Mycological Examination			
Typical Fusaria	No Panama Disease present		
Other Fusaria			

GUATEMALA DIVISION

SERIAL NUMBER *220*

Location: *Yuma* Farm, Section *22.*
Other distinguishing features: *Lagoon near long tram.*

Date: *September, 1916.*
Collector: *L. W. W.*

NATURAL FEATURES

Topography: *Bottom land.*
Drainage: *Natural.*
Flood conditions: *None.*
Silt deposition: *None.*
Type of forest growth: *Heavy.*

CULTIVATION HISTORY

When cleared and planted: *1911.*
Number of replantings: *None. Supplying only.* Why?
General condition when in production: *Good.*
Plowed? *No.* When? Grubbed? *No.* When?
Years in bananas: *Six.* Life of farm: *Still producing well.*
Years in bush or fallow: *Never.*
Other crops grown: *None.*

DISEASE HISTORY

When first noted: *None.*
Age of plants when attacked:
Rapidity of spread:
Treatment given:

OTHER DATA

	Surface—6"	6"—18"	18"—30"
Physical Examination			
Color	light brown	light brown	light brown
Compactness	loose	loose	loose
Friability	light	light	light
Retentive power	100	76	74
Mechanical Examination			
Coarse gravel	0	0	0
Fine gravel	0	0	0
Coarse sand	0	0	0
Fine sand	0	0	0
Silt	97.3	97.0	96.9
Clay	2.7	3.0	3.1
Chemical Examination			
Organic matter	3.54	4.76	5.57
Total Nitrogen	.23	.02	.11
Potash (K_2O)	.37	.29	.48
Phosphoric acid (P_2O_5)	.12	.14	.22
Lime (CaO)	.85	.71	.98
Magnesia (MgO)	.73	.24	1.34
Iron (Fe_2O_3)	5.17	1.90	5.12
Alumina (Al_2O_3)			
Silica, sol. (SiO_2)			
Free Acidity			
Mycological Examination			
Typical Fusaria	No Panama Disease present		
Other Fusaria			

GUATEMALA DIVISION

SERIAL NUMBER *221*

Location: *Seminole* Farm, Section *41*.

Other distinguishing features: *Tram No. 10, back of camps.*

Date: *September, 1916.*

Collector: *L. W. W.*

NATURAL FEATURES

Topography: *Bottom land.*
Drainage: *Natural.*
Flood conditions: *None.*
Silt deposition: *None.*
Type of forest growth: *Heavy.*

CULTIVATION HISTORY

When cleared and planted: *1913.*
Number of replantings: *None. Supplying only.* Why?
General condition when in production: *Poor.*
Plowed? *No.* When? Grubbed? *No.* When?
Years in bananas: *Four.* Life of farm:
Years in bush or fallow: *Never.*
Other crops grown: *None.*

DISEASE HISTORY

When first noted: *None.*
Age of plants when attacked:
Rapidity of spread:
Treatment given:

OTHER DATA

	Surface—6"	6"—18"	18"—30"
Physical Examination			
Color	light brown	light brown	light brown
Compactness	hard	hard	hard
Friability	stiff	stiff	stiff
Retentive power	86	70	67
Mechanical Examination			
Coarse gravel	0	0	0
Fine gravel	0	0	0
Coarse sand	0	0	0
Fine sand	0	0	0
Silt	95.9	95.1	94.4
Clay	4.1	4.9	5.6
Chemical Examination			
Organic matter	11.18	6.80	2.46
Total Nitrogen	.28	.15	.01
Potash (K_2O)	.42	.27	.42
Phosphoric acid (P_2O_5)	.34	.20	.14
Lime (CaO)	1.21	.92	.66
Magnesia (MgO)	1.51	.48	.67
Iron (Fe_2O_3)	5.43	6.63	6.37
Alumina (Al_2O_3)			
Silica, sol. (SiO_2)			
Free Acidity			
Mycological Examination			
Typical Fusaria	No Panama Disease present		
Other Fusaria			

GUATEMALA DIVISION

SERIAL NUMBER *222*

Location: *Cherokee* Farm, Section *30*. Date: *September, 1916.*

Other distinguishing features: *End main line on hilltop.* Collector: *L. W. W.*

NATURAL FEATURES

Topography: *Hilltop.*
Drainage: *Natural.*
Flood conditions: *None.*
Silt deposition: *None.*
Type of forest growth: *Heavy.*

CULTIVATION HISTORY

When cleared and planted: *1913.*
Number of replantings: *None. Supplying only.* Why?
General condition when in production: *Fair.*
Plowed? *No.* When? Grubbed? *No.* When?
Years in bananas: *Three.* Life of farm: *Abandoned this area in 1916, disease.*
Years in bush or fallow: *Never.*
Other crops grown: *None.*

DISEASE HISTORY

When first noted: *September, 1916.*
Age of plants when attacked: *Three years.*
Rapidity of spread: *Rapid.*
Treatment given: *Digging out, burning and bleaching.*

OTHER DATA

This area is badly diseased and has been abandoned.

	Surface—6"	6"—18"	18"—30"
Physical Examination			
Color	dark brown	light brown	light brown
Compactness	hard	hard	hard
Friability	stiff	stiff	stiff
Retentive power	62	46	54
Mechanical Examination			
Coarse gravel	0	0	0
Fine gravel	0	0	0
Coarse sand	0	0	0
Fine sand	0.8	0	0
Silt	94.8	97.3	96.2
Clay	4.4	2.7	3.8
Chemical Examination			
Organic matter	7.27	4.87	8.16
Total Nitrogen	.27	.09	.07
Potash (K_2O)	.12	.19	.12
Phosphoric acid (P_2O_5)	.11	.14	.08
Lime (CaO)	.26	.22	.07
Magnesia (MgO)	.14	.29	.94
Iron (Fe_2O_3)	3.41	4.42	4.71
Alumina (Al_2O_3)			
Silica, sol. (SiO_2)			
Free Acidity			
Mycological Examination			
Typical Fusaria	Area heavily diseased		
Other Fusaria			

GUATEMALA DIVISION

SERIAL NUMBER *223*

Location: *Chickasaw* Farm, Section *61.*

Other distinguishing features: *Near end of C line.*

Date: *September, 1916.*

Collector: *L. W. W.*

NATURAL FEATURES

Topography: *Bottom land.*
Drainage: *Natural.*
Flood conditions: *None.*
Silt deposition: *None.*
Type of forest growth: *Heavy.*

CULTIVATION HISTORY

When cleared and planted: *1913.*
Number of replantings: *None. Supplying only.* Why?
General condition when in production: *Good.*
Plowed? *No.* When? Grubbed? *No.* When?
Years in bananas: *Four.* Life of farm: *Good producer.*
Years in bush or fallow: *Never.*
Other crops grown: *None.*

DISEASE HISTORY

When first noted: *None.*
Age of plants when attacked:
Rapidity of spread:
Treatment given:

OTHER DATA

	Surface—6"	6"—18"	18"—30"
Physical Examination			
Color	brown	light brown	light brown
Compactness	loose	loose	loose
Friability	light	light	light
Retentive power	100	94	73
Mechanical Examination			
Coarse gravel	0	0	0
Fine gravel	0	0	0
Coarse sand	0	0	0
Fine sand	0	0	0
Silt	93.5	94.4	94.5
Clay	6.5	5.6	5.5
Chemical Examination			
Organic matter	10.35	8.84	5.23
Total Nitrogen	.44	.21	.14
Potash (K_2O)	.37	.56	.37
Phosphoric acid (P_2O_5)	.24	.18	.14
Lime (CaO)	1.17	1.15	1.13
Magnesia (MgO)	1.34	1.68	.61
Iron (Fe_2O_3)	6.43	19.58	6.29
Alumina (Al_2O_3)			
Silica, sol. (SiO_2)			
Free Acidity			
Mycological Examination			
Typical Fusaria	No Panama Disease present		
Other Fusaria			

GUATEMALA DIVISION

SERIAL NUMBER *224*

Location: *Choctaw* Farm, Section *45*. Date: *September, 1916.*

Other distinguishing features: *Back of overseer's house.* Collector: *L. W. W.*

NATURAL FEATURES

Topography: *Bottom land.*
Drainage: *Natural.*
Flood conditions: *None.*
Silt deposition: *None.*
Type of forest growth: *Heavy.*

CULTIVATION HISTORY

When cleared and planted: *1912.*
Number of replantings: *None. Supplying only.* Why?
General condition when in production: *Good.*
Plowed? *No.* When? Grubbed? *No.* When?
Years in bananas: *Five.* Life of farm: *Still good.*
Years in bush or fallow: *Never.*
Other crops grown: *None.*

DISEASE HISTORY

When first noted: *1916.*
Age of plants when attacked: *Four years.*
Rapidity of spread: *Slow.*
Treatment given: *Digging out, burning and bleaching.*

OTHER DATA

Sample taken near patch of disease.

	Surface—6"	6"—18"	18"—30"
Physical Examination			
Color	dark brown	light brown	light brown
Compactness	loose	loose	loose
Friability	light	light	light
Retentive power	67	50	51
Mechanical Examination			
Coarse sand	0	0	0
Fine gravel	0	0	0
Coarse sand	0	0	0
Fine sand	2.3	1.3	0
Silt	93.2	95.3	98.9
Clay	4.5	3.4	1.1
Chemical Examination			
Organic matter	5.20	2.59	3.65
Total Nitrogen	.27	.03	.08
Potash (K_2O)	.27	.09	.29
Phosphoric acid (P_2O_5)	.19	.09	.18
Lime (CaO)	1.71	.24	.59
Magnesia (MgO)	.99	1.07	.03
Iron (Fe_2O_3)	3.74	4.63	4.18
Alumina (Al_2O_3)			
Silica, sol. (SiO_2)			
Free Acidity			
Mycological Examination			
Typical Fusaria	Panama Disease present		
Other Fusaria			

GUATEMALA DIVISION

SERIAL NUMBER *225*

Location: *Oneida* Farm, Section *40*. Date: *September, 1916.*

Other distinguishing features: *Riverside.* Collector: *L. W. W.*

NATURAL FEATURES

Topography: *Bottom land.*
Drainage: *Open drains.*
Flood conditions: *About yearly.*
Silt deposition: *Several inches.*
Type of forest growth: *Heavy.*

CULTIVATION HISTORY

When cleared and planted: *1911.*
Number of replantings: *None. Supplying only.* Why?
General condition when in production: *Good.*
Plowed? *No.* When? Grubbed? *No.* When?
Years in bananas: *Six.* Life of farm: *Giving large fruit.*
Years in bush or fallow: *Never.*
Other crops grown: *None.*

DISEASE HISTORY

When first noted: *No Panama Disease, Colorado Disease in 1914.*
Age of plants when attacked: *Three years.*
Rapidity of spread: *Disappeared.*
Treatment given: *Digging out.*

OTHER DATA

	Surface—6"	6"—18"	18"—30"
Physical Examination			
Color	light brown	light brown	light brown
Compactness	loose	loose	loose
Friability	light	light	light
Retentive power	83	62	55
Mechanical Examination			
Coarse gravel	0	0	0
Fine gravel	0	0	0
Coarse sand	0	0	0.1
Fine sand	0	0	4.7
Silt	96.0	97.2	88.4
Clay	4.0	2.8	6.8
Chemical Examination			
Organic matter	10.55	3.09	5.07
Total Nitrogen	.30	.09	.09
Potash (K_2O)	.32	.36	.25
Phosphoric acid (P_2O_5)	.23	.14	.14
Lime (CaO)	1.07	.81	.38
Magnesia (MgO)	.65	1.11	.57
Iron (Fe_2O_3)	5.25	5.05	4.10
Alumina (Al_2O_3)			
Silica, sol. (SiO_2)			
Free Acidity			
Mycological Examination			
Typical Fusaria	No Panama Disease		
Other Fusaria	Colorado Disease present		

GUATEMALA DIVISION

SERIAL NUMBER *226*

Location: *Oneida* Farm, Section *26*. Date: *September, 1916.*

Other distinguishing features: *Talpetate ridge near woods.* Collector: *L. W. W.*

NATURAL FEATURES

Topography: *Upland.*
Drainage: *Good, natural.*
Flood conditions: *None.*
Silt deposition: *None.*
Type of forest growth: *Heavy.*

CULTIVATION HISTORY

When cleared and planted: *1911.*
Number of replantings: *None. Supplying only.* Why?
General condition when in production: *Good.*
Plowed? *No.* When? Grubbed? *No.* When?
Years in bananas: *Six.* Life of farm: *Good large fruit.*
Years in bush or fallow: *Never.*
Other crops grown: *None.*

DISEASE HISTORY

When first noted: *December, 1915.*
Age of plants when attacked: *Five years.*
Rapidity of spread: *Slow.*
Treatment given: *Digging out, burning, bleaching and abandoning.*

OTHER DATA

A considerable number of mats showing Panama Disease were dug out, the entire area cut down and burned and allowed to grow up in bush and abandoned.

	Surface—6"	6"—18"	18"—30"
Physical Examination			
Color	brown	light brown	light brown
Compactness	hard	hard	hard
Friability	refractory	refractory	refractory
Retentive power	89	74	72
Mechanical Examination			
Coarse gravel	0	0	0
Fine gravel	0	0	0
Coarse sand	0	0	0
Fine sand	0	0	0
Silt	95.9	95.4	98.5
Clay	4.1	4.6	1.5
Chemical Examination			
Organic matter	9.10	5.48	5.00
Total Nitrogen	.14	.12	.11
Potash (K_2O)	.30	.44	.41
Phosphoric acid (P_2O_5)	.16	.15	.16
Lime (CaO)	.71	.78	.74
Magnesia (MgO)	.40	1.02	1.57
Iron (Fe_2O_3)	6.57	5.98	5.63
Alumina (Al_2O_3)			
Silica, sol. (SiO_2)			
Free Acidity			
Mycological Examination			
Typical Fusaria	Panama Disease present		
Other Fusaria			

GUATEMALA DIVISION

SERIAL NUMBER *227*

Location: *Oncida* Farm, Section *51*. Date: *September, 1916.*

Other distinguishing features: *Talpetate ridge, back of camp.* Collector: *L. W. W.*

NATURAL FEATURES

Topography: *Upland.*
Drainage: *Natural.*
Flood conditions: *None.*
Silt deposition: *None.*
Type of forest growth: *Heavy.*

CULTIVATION HISTORY

When cleared and planted: *1911.*
Number of replantings: *None. Supplying only.* Why?
General condition when in production: *Good.*
Plowed? *No.* When? Grubbed? *No.* When?
Years in bananas: *Six.* Life of farm: *Badly diseased in this section.*
Years in bush or fallow: *Never.*
Other crops grown: *None.*

DISEASE HISTORY

When first noted: *December, 1915.*
Age of plants when attacked: *Five years.*
Rapidity of spread: *Slow.*
Treatment given: *Digging out, burning and abandoning.*

OTHER DATA

Same treatment as 226.

	Surface—6"	6"—18"	18"—30"
Physical Examination			
Color	dark brown	gray	light gray
Compactness	hard	hard	hard
Friability	refractory	refractory	refractory
Retentive power	60	40	52
Mechanical Examination			
Coarse gravel	0	0	0
Fine gravel	0	2.8	0
Coarse sand	0	21.4	0
Fine sand	0	34.6	0
Silt	99.3	40.1	98.4
Clay	0.7	1.1	1.6
Chemical Examination			
Organic matter	6.32	3.91	5.73
Total Nitrogen	.18	.08	.08
Potash (K_2O)	.73	.47	.12
Phosphoric acid (P_2O_5)	.42	.13	.01
Lime (CaO)	.22	.25	.30
Magnesia (MgO)	.13	.04	.25
Iron (Fe_2O_3)	2.30	1.58	3.30
Alumina (Al_2O_3)			
Silica, sol. (SiO_2)			
Free Acidity			
Mycological Examination			
Typical Fusaria	Panama Disease present		
Other Fusaria			

GUATEMALA DIVISION

SERIAL NUMBER *228*

Location: *Oneida* Farm, Section *51*. Date: *September, 1916.*

Other distinguishing features: *Talpetate ridge near railroad.* Collector: *L. W. W.*

NATURAL FEATURES

Topography: *Upland.*
Drainage: *Natural.*
Flood conditions: *None.*
Silt deposition: *None.*
Type of forest growth: *Heavy.*

CULTIVATION HISTORY

When cleared and planted: *1911.*
Number of replantings: *None. Supplying only.* Why?
General condition when in production: *Good.*
Plowed? *No.* When? Grubbed? *No.* When?
Years in bananas: *Six.* Life of farm: *Section badly diseased.*
Years in bush or fallow: *Never.*
Other crops grown: *None.*

DISEASE HISTORY

When first noted: *December, 1915.*
Age of plants when attacked: *Five years.*
Rapidity of spread: *Slow.*
Treatment given: *Digging out, burning and abandoning.*

OTHER DATA

Same treatment as 226 and 227.

	Surface—6"	6"—18"	18"—30"
Physical Examination			
Color	dark brown	gray	light gray
Compactness	hard	hard	hard
Friability	refractory	refractory	refractory
Retentive power	76	61	68
Mechanical Examination			
Coarse gravel	0	0	0
Fine gravel	0	0	0
Coarse sand	0	0	0
Fine sand	0	0	0
Silt	98.7	98.8	98.9
Clay	1.3	1.2	1.1
Chemical Examination			
Organic matter	7.19	6.48	6.17
Total Nitrogen	.27	.10	.07
Potash (K_2O)	.14	.01	.16
Phosphoric acid (P_2O_5)	.11	.10	.02
Lime (CaO)	.94	.30	.44
Magnesia (MgO)	.38	.19	.07
Iron (Fe_2O_3)	4.94	1.73	2.29
Alumina (Al_2O_3)			
Silica, sol. (SiO_2)			
Free Acidity			
Mycological Examination			
Typical Fusaria	Panama Disease present		
Other Fusaria			

GUATEMALA DIVISION

SERIAL NUMBER *229*

Location: *Mixco* Farm, Section *42*. Date: *September, 1916.*

Other distinguishing features: *Lower end of farm near end of rails.* Collector: *L. W. W.*

NATURAL FEATURES

Topography: *Hillside.*
Drainage: *Natural.*
Flood conditions: *None.*
Silt deposition: *None.*
Type of forest growth: *Heavy.*

CULTIVATION HISTORY

When cleared and planted: *1914.*
Number of replantings: *Two per cent.* Why? *Plants did not come up.*
General condition when in production: *Fair.*
Plowed? *No.* When? Grubbed? *No.* When?
Years in bananas: *Three.* Life of farm: *Fair prospects.*
Years in bush or fallow: *Never.*
Other crops grown: *None.*

DISEASE HISTORY

When first noted: *July, 1916.*
Age of plants when attacked: *Three years.*
Rapidity of spread: *Medium.*
Treatment given: *Digging out, burning and bleaching.*

OTHER DATA

First spot of disease found on farm.

	Surface—6"	6"—18"	18"—30"
Physical Examination			
Color	light brown	light brown	light brown
Compactness	loose	loose	loose
Friability	light	light	light
Retentive power	76	53	47
Mechanical Examination			
Coarse gravel	0	0	0
Fine gravel	0	0	0
Coarse sand	0	0	0
Fine sand	0	0	0
Silt	98.2	98.7	99.0
Clay	1.8	1.3	1.0
Chemical Examination			
Organic matter	8.05	4.93	3.82
Total Nitrogen	.21	.09	.07
Potash (K_2O)	.10	.28	.29
Phosphoric acid (P_2O_5)	.20	.07	.04
Lime (CaO)	.54	.27	.15
Magnesia (MgO)	.13	.32	.28
Iron (Fe_2O_3)	3.43	2.19	3.05
Alumina (Al_2O_3)			
Silica, sol. (SiO_2)			
Free Acidity			
Mycological Examination			
Typical Fusaria	Panama Disease present		
Other Fusaria			

GUATEMALA DIVISION

SERIAL NUMBER *230*

Location: *Sioux* Farm, Section *14*. Date: *September, 1916.*

Other distinguishing features: *Middle of section.* Collector: *L. R. Whittard.*

NATURAL FEATURES

Topography: *Bottom land.*
Drainage: *Open ditches.*
Flood conditions: *Four to six times a year.*
Silt deposition: *Three to four inches.*
Type of forest growth: *Heavy.*

CULTIVATION HISTORY

When cleared and planted: *1914.*
Number of replantings: *None.* Why? *Area waterlogged.*
General condition when in production: *Never came into bearing.*
Plowed? *No.* When? Grubbed? *No.* When?
Years in bananas: Life of farm:
Years in bush or fallow: *None.*
Other crops grown: *None.*

DISEASE HISTORY

When first noted: *None.*
Age of plants when attacked:
Rapidity of spread:
Treatment given:

OTHER DATA

Section has been repeatedly supplied, but never did well. Has not been abandoned owing to continued floods.

	Surface—6"	6"—18"	18"—30"
Physical Examination			
Color	light brown	light brown	light brown
Compactness	hard	hard	hard
Friability	stiff	stiff	stiff
Retentive power	91	80	77
Mechanical Examination			
Coarse gravel	0	0	0
Fine gravel	0	0	0
Coarse sand	0	0	0
Fine sand	0	0	0
Silt	97.8	97.8	98.1
Clay	2.2	2.2	1.9
Chemical Examination			
Organic matter	9.58	8.46	7.95
Total Nitrogen	.30	.15	.10
Potash (K_2O)	.59	.56	.50
Phosphoric acid (P_2O_5)	.20	.15	.09
Lime (CaO)	.92	.42	.51
Magnesia (MgO)	.44	.55	.13
Iron (Fe_2O_3)	5.98	8.18	6.87
Alumina (Al_2O_3)			
Silica, sol. (SiO_2)			
Free Acidity			
Mycological Examination			
Typical Fusaria	No Panama Disease present		
Other Fusaria			

GUATEMALA DIVISION

SERIAL NUMBER *231*

Location: *Comanche* Farm, Section *36*. Date: *October, 1916.*

Other distinguishing features: *End of Apache tram line.* Collector: *L. R. Whittard.*

NATURAL FEATURES

Topography: *Bottom land.*
Drainage: *Natural.*
Flood conditions: *Three or four times a year.*
Silt deposition: *Four to six inches.*
Type of forest growth: *Mannaca and wild cane, rest of farm heavy forest.*

CULTIVATION HISTORY

When cleared and planted: *1916.*
Number of replantings: *None.* Why?
General condition when in production: *Not in bearing.*
Plowed? *No.* When? Grubbed? *No.* When?
Years in bananas: *Few months.* Life of farm: *Much damaged by floods.*
Years in bush or fallow: *Never.*
Other crops grown: *None.*

DISEASE HISTORY

When first noted: *None.*
Age of plants when attacked:
Rapidity of spread:
Treatment given:

OTHER DATA

	Surface—6"	6"—18"	18"—30"
Physical Examination			
Color	light brown	light brown	light brown
Compactness	firm	firm	firm
Friability	stiff	stiff	stiff
Retentive power	100	80	72
Mechanical Examination			
Coarse gravel	0	0	0
Fine gravel	0	0	0
Coarse sand	0	0	0
Fine sand	0	0	0
Silt	97.4	98.0	97.7
Clay	2.6	2.0	2.3
Chemical Examination			
Organic matter	13.42	8.80	6.18
Total Nitrogen	.48	.21	.13
Potash (K_2O)	.49	.53	.38
Phosphoric acid (P_2O_5)	.27	.20	.14
Lime (CaO)	1.15	1.13	1.06
Magnesia (MgO)	1.25	1.87	.64
Iron (Fe_2O_3)	6.37	5.85	5.85
Alumina (Al_2O_3)			
Silica, sol. (SiO_2)			
Free Acidity			
Mycological Examination			
Typical Fusaria	No Panama Disease present		
Other Fusaria			

GUATEMALA DIVISION

SERIAL NUMBER *232*

Location: *Sacramento* Farm, Section *; Central lands.* Date: *October, 1916.*

Other distinguishing features: *Woodland near Chinameta River.* Collector: *L. R. Whittard.*

NATURAL FEATURES

Topography: *Bottom land.*
Drainage: *Natural.*
Flood conditions: *Seldom.*
Silt deposition: *None.*
Type of forest growth: *Heavy forest and bamboo.*

CULTIVATION HISTORY

When cleared and planted: *Virgin woodland.*
Number of replantings: Why?
General condition when in production:
Plowed? When? Grubbed? When?
Years in bananas: Life of farm:
Years in bush or fallow:
Other crops grown:

DISEASE HISTORY

When first noted: *None.*
Age of plants when attacked:
Rapidity of spread:
Treatment given:

OTHER DATA

	Surface—6"	6"—18"	18"—30"
Physical Examination			
Color	dark brown	brown	light brown
Compactness	loose	loose	loose
Friability	light	light	light
Retentive power	66	63	59
Mechanical Examination			
Coarse gravel	0	0	0
Fine gravel	0	0	0
Coarse sand	0	0	0
Fine sand	0	0	0
Silt	98.9	99.0	99.1
Clay	1.1	1.0	0.9
Chemical Examination			
Organic matter	3.81	4.92	3.79
Total Nitrogen	.20	.01	.09
Potash (K_2O)	.51	1.04	.31
Phosphoric acid (P_2O_5)	.14	.13	.14
Lime (CaO)	.62	1.12	.45
Magnesia (MgO)	.80	1.14	.51
Iron (Fe_2O_3)	4.94	6.02	5.62
Alumina (Al_2O_3)			
Silica, sol. (SiO_2)			
Free Acidity			
Mycological Examination			
Typical Fusaria	No Panama Disease present		
Other Fusaria			

GUATEMALA DIVISION

SERIAL NUMBER *233*

Location: Farm, Section .

Date: *October, 1916.*

Other distinguishing features: *Central lands half way between Sacramento and Plietas.*

Collector: *L. R. Whittard.*

NATURAL FEATURES

Topography: *Bottom land.*
Drainage: *Natural.*
Flood conditions: *None.*
Silt deposition: *None.*
Type of forest growth: *Heavy forest and mannaca.*

CULTIVATION HISTORY

When cleared and planted: *Virgin woodland.*
Number of replantings: Why?
General condition when in production:
Plowed? When? Grubbed? When?
Years in bananas: Life of farm:
Years in bush or fallow:
Other crops grown:

DISEASE HISTORY

When first noted: *None.*
Age of plants when attacked:
Rapidity of spread:
Treatment given:

OTHER DATA

	Surface—6"	6"—18"	18"—30"
Physical Examination			
Color	light brown	light brown	light brown
Compactness	loose	loose	loose
Friability	light	light	light
Retentive power	81	71	51
Mechanical Examination			
Coarse gravel	0	0	0
Fine gravel	0	0	0
Coarse sand	0	0	0
Fine sand	0	0	0
Silt	98.8	98.7	98.6
Clay	1.2	1.3	1.4
Chemical Examination			
Organic matter	4.38	3.91	2.56
Total Nitrogen	.14	.08	.08
Potash (K_2O)	.58	.58	.26
Phosphoric acid (P_2O_5)	.16	.14	.04
Lime (CaO)	.76	.41	1.03
Magnesia (MgO)	1.03	1.17	1.24
Iron (Fe_2O_3)	5.47	5.33	4.48
Alumina (Al_2O_3)			
Silica, sol. (SiO_2)			
Free Acidity			
Mycological Examination			
Typical Fusaria	No Panama Disease		
Other Fusaria			

GUATEMALA DIVISION

SERIAL NUMBER *234*

Location: *Plietas* Farm, Section .

Date: *October, 1916.*

Other distinguishing features: *Near foothills.*

Collector: *L. R. Whittard.*

NATURAL FEATURES

Topography: *Bottom land.*
Drainage: *Natural.*
Flood conditions: *Never.*
Silt deposition: *None.*
Type of forest growth: *Wild cane and bamboo.*

CULTIVATION HISTORY

When cleared and planted: *Virgin forest.*
Number of replantings: Why?
General condition when in production:
Plowed? When? Grubbed? When?
Years in bananas: Life of farm:
Years in bush or fallow:
Other crops grown:

DISEASE HISTORY

When first noted: *None.*
Age of plants when attacked:
Rapidity of spread:
Treatment given:

OTHER DATA

The sample was taken near a patch of bananas planted as an experiment three years ago. Bananas are in excellent condition.

	Surface—6"	6"—18"	18"—30"
Physical Examination			
Color	brown	brown	brown
Compactness	loose	loose	loose
Friability	light	light	light
Retentive power	46	39	43
Mechanical Examination			
Coarse gravel	0	0	0
Fine gravel	0	0	0
Coarse sand	0	0	0
Fine sand	8.4	22.7	9.0
Silt	90.6	76.7	90.4
Clay	1.0	0.6	0.6
Chemical Examination			
Organic matter	3.72	2.83	2.12
Total Nitrogen	.13	.08	.06
Potash (K_2O)	.51	.18	.28
Phosphoric acid (P_2O_5)	.21	.14	.09
Lime (CaO)	.45	.39	1.35
Magnesia (MgO)	.46	.55	.79
Iron (Fe_2O_3)	3.83	4.57	4.77
Alumina (Al_2O_3)			
Silica, sol. (SiO_2)			
Free Acidity			
Mycological Examination			
Typical Fusaria	No Panama Disease		
Other Fusaria			

GUATEMALA DIVISION

SERIAL NUMBER *235*

Location: *Apache* Farm, Section *49*. Date: *October, 1916.*

Other distinguishing features: *Near railroad.* Collector: *L. R. Whittard.*

NATURAL FEATURES

Topography: *Bottom land.*
Drainage: *Natural.*
Flood conditions: *Three or four times yearly.*
Silt deposition: *Four to six inches.*
Type of forest growth: *Heavy.*

CULTIVATION HISTORY

When cleared and planted: *1914.*
Number of replantings: *One.* Why? *Floods.*
General condition when in production: *Has not produced.*
Plowed? *No.* When? Grubbed? *No.* When?
Years in bananas: *Two.* Life of farm: *Looked promising before floods.*
Years in bush or fallow: *Never.*
Other crops grown: *None.*

DISEASE HISTORY

When first noted: *None.*
Age of plants when attacked:
Rapidity of spread:
Treatment given:

OTHER DATA

Heavy floods seriously damaged this section in 1916, requiring thorough supplying.

	Surface—6"	6"—18"	18"—30"
Physical Examination			
Color	dark brown	dark brown	dark brown
Compactness	hard	hard	hard
Friability	stiff	stiff	stiff
Retentive power	92	72	65
Mechanical Examination			
Coarse gravel	0	0	0
Fine gravel	0	0	0
Coarse sand	0	0	0
Fine sand	0	0	0
Silt	94.6	95.4	95.7
Clay	5.4	4.6	4.3
Chemical Examination			
Organic matter	10.10	7.97	4.86
Total Nitrogen	.34	.17	.11
Potash (K_2O)	.41	.45	.25
Phosphoric acid (P_2O_5)	.53	.15	.38
Lime (CaO)	.94	.80	.94
Magnesia (MgO)	.42	.26	1.15
Iron (Fe_2O_3)	4.56	6.34	6.26
Alumina (Al_2O_3)			
Silica, sol. (SiO_2)			
Free Acidity			
Mycological Examination			
Typical Fusaria	No Panama Disease		
Other Fusaria			

GUATEMALA DIVISION

SERIAL NUMBER *236*

Location: *Quiche* Farm, Section .
Date: *February, 1917.*

Other distinguishing features: *Hill sections.*
Collector: *Sent by Mr. Shaw.*

NATURAL FEATURES

Topography: *Upland.*
Drainage: *Good.*
Flood conditions: *None.*
Silt deposition: *None.*
Type of forest growth: *Heavy.*

CULTIVATION HISTORY

When cleared and planted:
Number of replantings: Why?
General condition when in production:
Plowed? When? Grubbed? When?
Years in bananas: Life of farm:
Years in bush or fallow:
Other crops grown:

DISEASE HISTORY

When first noted:
Age of plants when attacked:
Rapidity of spread:
Treatment given:

OTHER DATA

This sample and 237, 238 and 239 were sent later by Mr. Shaw and no records are available.

	Surface—6″	6″—18″	18″—30″
Physical Examination			
Color	dark brown	light brown	gray
Compactness	hard	hard	hard
Friability	refractory	refractory	refractory
Retentive power	71	66	56
Mechanical Examination			
Coarse gravel	0	0	0
Fine gravel	0	0	0
Coarse sand	0	0	0
Fine sand	0	0	0
Silt	97.5	97.3	97.4
Clay	2.5	2.7	2.6
Chemical Examination			
Organic matter	9.58	6.78	3.68
Total Nitrogen	.29	.11	.07
Potash (K_2O)	.28	.30	.09
Phosphoric acid (P_2O_5)	.16	.08	.07
Lime (CaO)	.53	.25	.07
Magnesia (MgO)	.38	1.04	.08
Iron (Fe_2O_3)	1.59	1.89	1.67
Alumina (Al_2O_3)			
Silica, sol. (SiO_2)			
Free Acidity			
Mycological Examination			
Typical Fusaria			
Other Fusaria			

GUATEMALA DIVISION

SERIAL NUMBER *237*

Location: *Quiche* Farm, Section .

Date: *February, 1917.*

Collector: *Sent by Mr. G. M. Shaw.*

Other distinguishing features:

NATURAL FEATURES

Topography: *Upland.*
Drainage: *Good.*
Flood conditions: *None.*
Silt deposition: *None.*
Type of forest growth: *Heavy.*

CULTIVATION HISTORY

When cleared and planted:
Number of replantings: Why?
General condition when in production:
Plowed? When? Grubbed? When?
Years in bananas: Life of farm:
Years in bush or fallow:
Other crops grown:

DISEASE HISTORY

When first noted:
Age of plants when attacked:
Rapidity of spread:
Treatment given:

OTHER DATA

See 236.

	Surface—6"	6"—18"	18"—30"
PHYSICAL EXAMINATION			
Color	dark brown	light brown	gray
Compactness	hard	hard	hard
Friability	refractory	refractory	refractory
Retentive power	66	47	54
MECHANICAL EXAMINATION			
Coarse gravel	0	0	0
Fine gravel	0	0	0
Coarse sand	0	0	0
Fine sand	29.1	0	25.6
Silt	68.9	97.7	70.7
Clay	2.0	2.3	3.7
CHEMICAL EXAMINATION			
Organic matter	7.32	4.87	4.73
Total Nitrogen	.48	.09	.07
Potash (K_2O)	.19	.25	.24
Phosphoric acid (P_2O_5)	.15	.13	.08
Lime (CaO)	.40	.96	.29
Magnesia (MgO)	.97	.11	.15
Iron (Fe_2O_3)	1.86	5.52	2.41
Alumina (Al_2O_3)			
Silica, sol. (SiO_2)			
Free Acidity			
MYCOLOGICAL EXAMINATION			
Typical Fusaria			
Other Fusaria			

GUATEMALA DIVISION

SERIAL NUMBER *238*

Location: *Quiche* Farm, Section .

Date: *February, 1917.*

Other distinguishing features:

Collector: *Sent by Mr. G. M. Shaw.*

NATURAL FEATURES

Topography:
Drainage:
Flood conditions:
Silt deposition:
Type of forest growth:

CULTIVATION HISTORY

When cleared and planted:
Number of replantings: Why?
General condition when in production:
Plowed? When? Grubbed? When?
Years in bananas: Life of farm:
Years in bush or fallow:
Other crops grown:

DISEASE HISTORY

When first noted:
Age of plants when attacked:
Rapidity of spread:
Treatment given:

OTHER DATA

See 236.

	Surface—6"	6"—18"	18"—30"
Physical Examination			
Color	dark brown	red brown	red brown
Compactness	loose	loose	loose
Friability	refractory	refractory	refractory
Retentive power	55	56	63
Mechanical Examination			
Coarse gravel	0	0	0
Fine gravel	0	0	0
Coarse sand	0	0	0
Fine sand	25.6	28.4	23.8
Silt	72.0	69.0	72.7
Clay	2.4	2.6	3.5
Chemical Examination			
Organic matter	1.54	5.52	10.53
Total Nitrogen	.32	.09	.04
Potash (K_2O)	.09	.06	.09
Phosphoric acid (P_2O_5)	.17	.16	.14
Lime (CaO)	.70	.27	.03
Magnesia (MgO)	.10	.15	.01
Iron (Fe_2O_3)	2.64	4.37	4.43
Alumina (Al_2O_3)			
Silica, sol. (SiO_2)			
Free Acidity			
Mycological Examination			
Typical Fusaria			
Other Fusaria			

GUATEMALA DIVISION

SERIAL NUMBER *239*

Location: *Quiche* Farm, Section .

Date: *February, 1917.*

Other distinguishing features:

Collector: *Sent by Mr. G. M. Shaw.*

NATURAL FEATURES

Topography: *Upland.*
Drainage: *Good.*
Flood conditions: *None.*
Silt deposition: *None.*
Type of forest growth: *Heavy.*

CULTIVATION HISTORY

When cleared and planted:
Number of replantings: Why?
General condition when in production:
Plowed? When? Grubbed? When?
Years in bananas: Life of farm:
Years in bush or fallow:
Other crops grown:

DISEASE HISTORY

When first noted:
Age of plants when attacked:
Rapidity of spread:
Treatment given:

OTHER DATA

See 236.

	Surface—6"	6"—18"	18"—30"
Physical Examination			
Color	light brown	light brown	light brown
Compactness	hard	hard	hard
Friability	refractory	refractory	refractory
Retentive power	79	53	63
Mechanical Examination			
Coarse gravel	0	0	0
Fine gravel	0	0	0
Coarse sand	0	0	0
Fine sand	0	28.5	0
Silt	98.2	69.7	98.1
Clay	1.8	1.8	1.9
Chemical Examination			
Organic matter	4.85	3.79	.78
Total Nitrogen	.18	.09	.10
Potash (K_2O)	.13	.11	.11
Phosphoric acid (P_2O_5)	.11	.10	.11
Lime (CaO)	.31	.23	.26
Magnesia (MgO)	.15	.08	.06
Iron (Fe_2O_3)	2.53	3.09	4.56
Alumina (Al_2O_3)			
Silica, sol. (SiO_2)			
Free Acidity			
Mycological Examination			
Typical Fusaria			
Other Fusaria			

AVERAGE ANALYSES—GUATEMALA

Sample	Fine Gravel	Coarse Sand	Fine Sand	Silt	Clay	K_2O	CaO	MgO	Fe_2O_3	P_2O_5	Vol. Mat.	Total N	RP
Pequot	0	0	0	92.3	7.7	.63	.13	.26	5.22	.22	6.08	.17	63
Dartmouth	0	0	0	94.6	5.4	.27	1.17	.51	5.55	.18	6.64	.20	87
Oneida	0	0	0	97.8	2.2	.14	.33	.22	2.85	.06	5.71	.16	78
Oneida	0	0	0	98.2	1.8	.16	.27	.33	1.53	.06	6.34	.15	76
Oneida	0	0	0	97.5	2.5	.09	.09	.18	2.83	.06	5.58	.10	58
Virginia	0	2.6	20.1	74.0	3.3	.47	.09	.16	2.12	.26	5.53	.09	69
Cayuga	0	0	0	95.9	4.1	.43	.90	.97	5.65	.16	5.31	.15	79
Navajo	0	0	0	96.5	3.5	.32	.93	.88	5.52	.24	5.95	.25	70
Dartmouth	0	0	0	97.3	2.7	.31	.85	.75	6.12	.21	5.90	.13	77
Navajo	0	0	0	98.0	2.0	.13	.46	.14	3.85	.17	7.55	.28	59
York	0	0	0	98.4	1.6	.13	.09	.13	2.29	.04	4.41	.08	56
York	0	0	8.4	89.7	1.9	.14	.31	.12	2.32	.14	5.91	.13	66
Toltec	0	0.2	30.4	68.7	.7	.22	.44	.21	1.74	.09	3.75	.08	50
Quirigua	0	0	0	98.8	1.2	.38	.89	.76	4.61	.15	4.85	.13	61
Aztec	0	0	4.2	93.4	2.4	.26	.74	.32	4.66	.21	3.55	.08	66
Nahua	0	0	0	96.0	4.0	.33	.75	.46	6.37	.22	8.27	.26	52
Puebla	0	0	0.3	94.2	5.5	.37	.79	.81	5.64	.17	5.74	.23	68
Tehuana	0	0	0	95.6	4.4	.36	.77	.62	5.28	.15	4.56	.14	80
Quiche	0	0	11.4	86.7	1.9	.65	.84	.82	2.78	.27	3.58	.09	45
Yuma	0	0	0	97.1	2.9	.38	.95	.78	3.84	.17	5.84	.10	80
Seminole	0	0	0	95.0	5.0	.36	.87	.76	6.28	.20	5.94	.12	72
Cherokee	0	0	0.1	96.4	3.5	.15	.17	.52	4.33	.11	6.66	.12	52
Chickasaw	0	0	0	94.3	5.7	.45	1.15	1.18	11.59	.17	7.69	.23	87
Choctaw	0	0	1.0	96.3	2.7	.20	.67	.64	4.27	.15	3.53	.10	54

Oneida	0	0	1.8	93.6	4.6	.31	.69	.80	4.71	.16	5.37	.13	63
Oneida	0	0	0	96.8	3.2	.40	.75	1.11	5.96	.16	6.01	.12	76
Oneida	1.1	8.5	13.8	75.4	1.2	.33	.26	.14	2.43	.14	5.12	.10	49
Oneida	0	0	0	98.8	1.2	.10	.48	.18	2.59	.07	6.49	.12	67
Mixco	0	0	0	98.7	1.3	.25	.27	.27	2.78	.08	5.11	.11	55
Sioux	0	0	0	97.9	2.1	.54	.55	.36	7.21	.13	8.46	.16	81
Comanche	0	0	0	97.8	2.2	.46	1.11	1.25	5.95	.19	8.76	.23	81
Sacramento	0	0	0	99.1	0.9	.64	.75	.82	5.64	.13	4.24	.08	62
Central Lands	0	0	0	98.7	1.3	.45	.73	1.17	5.02	.10	3.46	.09	65
Plietas	0	0	14.4	84.9	0.7	.28	.78	.63	4.50	.13	2.72	.08	42
Apache	0	0	0	95.4	4.6	.36	.88	.65	5.95	.32	7.15	.18	73
Quiche	0	0	0	97.4	2.6	.21	.23	.52	1.74	.09	6.10	.13	63
Quiche	0	0	16.0	81.4	2.8	.28	.58	.29	3.54	.11	5.30	.16	53
Quiche	0	0	25.9	71.2	2.9	.07	.26	.08	4.05	.15	6.73	.11	58
Quiche	0	0	11.4	86.8	1.8	.11	.26	.08	3.56	.11	2.79	.11	62
Whole Division	0.3	0.2	3.4	93.1	3.0	.31	.61	.63	4.66	.15	5.67	.14	64

AVERAGE OF RESULTS BY DISTRICTS

Los Andes	0	0.3	3.2	92.7	3.8	.31	.56	.43	4.29	.18	5.92	.16	69
Bobos	0.1	0.7	2.3	94.7	2.2	.33	.59	.89	4.40	.13	5.79	.13	67
Quirigua	0	0	8.3	89.1	2.6	.29	.57	.44	3.90	.15	5.03	.14	51
El Pilar	0	0	0.2	95.9	3.9	.31	.74	.77	6.06	.16	5.93	.13	69
No Silt	0.6	0.4	6.2	89.6	3.2	.22	.39	.50	3.72	.11	5.39	.14	57
Silt Deposit	0	0	0.6	96.6	2.8	.40	.83	.76	5.60	.19	5.95	.14	71

Ratio of Lime to Magnesia

The following table shows the ratios of lime to magnesia in the Guatemala Division. It would be noted that in this case there is frequently a predominance of magnesia over lime, indicating in general that lime treatment might be desirable on these soils.

Ratio of Lime to Magnesia

1–1 to 5–1 regarded as normal

201. Pequot	208. Navajo	215. Aztec
.9–1	1.5–1	1.5–1
.6–1	.8–1	1.5–1
.3–1	1.1–1	7.0–1
202. Dartmouth	209. Dartmouth	216. Nahua
3.0–1	.8–1	1.8–1
2.0–1	1.4–1	1.5–1
4.0–1	1.6–1	
203. Oneida	210. Navajo	217. Puebla
2.0–1	8.0–1	.7–1
.7–1	3.5–1	6.0–1
5.0–1	1.3–1	.7–1
204. Oneida	211. York	218. Tehuana
.8–1	.9–1	4.0–1
.2–1	2.0–1	2.0–1
3.0–1	.3–1	.8–1
205. Oneida	212. York	219. Quiche
.4–1	8.0–1	.7–1
.6–1	7.0–1	1.0–1
.9–1	.6–1	1.3–1
206. Virginia	213. Toltec	220. Yuma
.05–1	2.0–1	1.0–1
1.2–1	.8–1	3.0–1
1.0–1	4.0–1	.6–1
207. Cayuga	214. Quirigua	221. Seminole
1.2–1	1.2–1	.8–1
2.0–1	1.1–1	2.0–1
.5–1	1.0–1	1.0–1

222. Cherokee
2.0–1
.8–1
.06–1

223. Chickasaw
.9–1
.7–1
1.8–1

224. Choctaw
2.0–1
.2–1
27.0–1

225. Oneida
1.6–1
.8–1
.6–1

226. Oneida
1.7–1
.7–1
.5–1

227. Oneida
2.0–1
6.0–1
1.2–1

228. Oneida
3.0–1
1.6–1
6.0–1

229. Mixco
4.0–1
.8–1
.5–1

230. Sioux
2.0–1
.8–1
4.0–1

231. Comanche
.9–1
.6–1
1.6–1

232. Sacramento
.7–1
1.0–1
.8–1

233. Central Lands
.7–1
.4–1
.9–1

234. Plietas
1.0–1
.8–1
2.0–1

235. Apache
2.0–1
3.0–1
.8–1

236. Quiche
1.6–1
.2–1
.8–1

237. Quiche
.4–1
8.0–1
2.0–1

238. Quiche
7.0–1
2.0–1
3.0–1

239. Quiche
2.0–1
3.0–1
4.0–1

Ratio of Organic Matter to Nitrogen

30–1 to 40–1 regarded as normal

201. Pequot
28.0–1
30.0–1
43.0–1

202. Dartmouth
25.0–1
77.0–1
43.0–1

203. Oneida
19.0–1
33.0–1
80.0–1

204. Oneida
34.0–1
38.0–1
63.0–1

205. Oneida
33.0–1
67.0–1
78.0–1

206. Virginia
41.0–1
47.0–1
129.0–1

207. Cayuga
27.0–1
39.0–1
38.0–1

208. Navajo
22.0–1
22.0–1
29.0–1

209. Dartmouth
86.0–1
33.0–1
32.0–1

210. Navajo
25.0–1
27.0–1
31.0–1

211. York
45.0–1
33.0–1
84.0–1

212. York
35.0–1
33.0–1
66.0–1

213. Toltec
34.0–1
54.0–1
53.0–1

214. Quirigua
39.0–1
31.0–1
49.0–1

215. Aztec
39.0–1
44.0–1
42.0–1

216. Nahua
310.0–1
26.0–1
37.0–1

217. Puebla
390.0–1
41.0–1
22.0–1

218. Tehuana
29.0–1
29.0–1
43.0–1

219. Quiche
35.0–1
48.0–1
25.0–1

220. Yuma
37.0–1
238.0–1
50.0–1

221. Seminole
37.0–1
45.0–1
246.0–1

222. Cherokee
26.0–1
54.0–1
116.0–1

223. Chickasaw
23.0–1
42.0–1
36.0–1

224. Choctaw
19.0–1
36.0–1
45.0–1

225. Oneida
35.0–1
34.0–1
56.0–1

226. Oneida
65.0–1
45.0–1
48.0–1

227. Oneida
39.0–1
48.0–1
71.0–1

228. Oneida
25.0–1
64.0–1
88.0–1

229. Mixco
38.0–1
54.0–1
54.0–1

230. Sioux
32.0–1
56.0–1
79.0–1

231. Comanche
27.0–1
44.0–1
46.0–1

232. Sacramento
19.0–1
492.0–1
42.0–1

233. Central Lands
31.0–1
49.0–1
32.0–1

234. Plietas
26.0–1
35.0–1
35.0–1

235. Apache
30.0–1
48.0–1
42.0–1

236. Quiche
33.0–1
62.0–1
52.0–1

237. Quiche
13.0–1
54.0–1
67.0–1

238. Quiche
50.0–1
61.0–1
263.0–1

239. Quiche
26.0–1
42.0–1
7.8–1

Examination of Individual Farms

Pequot. The silt is hard and refractory and has low phosphoric acid content and high iron content, a combination which is regarded as objectionable.

Dartmouth, Sec. 32. A well-balanced soil except for a slight deficiency in organic matter in the surface section.

Oneida. Rather thin soil, as shown by the falling off in organic matter, nitrogen, potash and phosphoric acid. The subsoil is also hard and refractory, preventing suitable rootage.

Oneida, Sec. 15. Subsoil is refractory, but otherwise the soil is of fairly good depth, although very low in phosphoric acid. This may be regarded as only a fair soil.

Oneida, Sec. 16. A hard, refractory soil, thin and very low in lime, and phosphoric acid in the superficial layers. The subsoil gives a very good analysis.

Cayuga Bend. A rich soil, although slightly lower than desired in phosphoric acid.

Navajo Bend. A good rich soil.

Dartmouth, Sec. 2. A good soil with rather less phosphoric acid than is desirable in view of the iron content.

Navajo, Sec. 54. A thin soil low in potash and phosphoric acid.

York, Sec. 16. Hard, refractory and thin, low in potash, phosphoric acid, lime and organic matter.

York, Sec. 13. Hard, refractory soil, poor and thin, not quite as bad as the preceding.

Toltec, Sec. 57. A soil very low in organic matter, hard and refractory, preventing good rootage.

Quirigua, Sec. 114. A good soil with excellent depth.

Aztec, Sec. 29. A good soil.

Nahua. A loose, light soil rather high in nitrogen and low in phosphoric acid when compared with the iron content.

Puebla, Sec. 27. A soil with high superficial organic matter, but very poor in this respect in the deeper layers.

Tehuana. A good soil rather low in phosphoric acid.

Quiche. A thin soil, the deeper layers being very low in organic matter, nitrogen and phosphoric acid, although presenting high potash figures.

Yuma, Sec. 22. A good soil.

Seminole, Sec. 41. A hard, stiff soil which is also thin, very low in organic matter, nitrogen and phosphoric acid in the deeper layers.

Cherokee. A hard, stiff soil which is also thin, lacks lime, potash and phosphoric acid.

Chickasaw. A soil of good quality and depth except for a lack of phosphoric acid in view of the high iron.

Choctaw, Sec. 45. A very light soil rather poor in nutritive quality, but of good depth.

Oneida, Sec. 62. A hard, refractory soil of fair quality and depth.

Oneida, Sec. 40. A good soil of excellent depth.

Oneida, Sec. 51. A refractory soil which is thin and shows deficiency in organic matter, nitrogen, phosphoric acid and lime.

Oneida, Sec. 51. Near railroad. A refractory, hard soil which is very thin, deficient in nitrogen and phosphoric acid.

Mixco, Sec. 42. A light soil low in organic matter and phosphoric acid.

Sioux, Sec. 14. A stiff, hard soil rather than thin, but so subject to flooding that this rather than the chemical conditions probably affected its productivity.

Comanche, Sec. 36. A soil of excellent quality which should be good if not too much flooded.

Sacramento. A virgin woodland of good quality rich in potash and fair in lime and phosphoric acid.

Sacramento-Plietas. A virgin woodland rather thin, but rich in potash, lime.

Plietas. A light, loose, rather thin soil.

Apache, Sec. 48. A stiff, hard soil of good quality and depth. Should be productive if not overflooded.

Quiche. Three samples from uplands, all of which are thin, low in total nitrogen, potash and phosphoric acid.

Tabular View of Soil Conditions

Explanation of Abbreviations

Potash— h = greater than .30%
l = less than .15%

Lime— h = greater than 2%
l = less than 1%

Organic Matter—h = greater than 15%
l = less than 9%

Nitrogen— h = greater than .30%
l = less than .15%

Phosphoric Acid—h = greater than .30%
l = less than .15%

h = high m = medium r = rapid * = hard, refractory soil
l = low v = very s = slow

Farm	*History*	*Depth*	*Potash*	*Lime*	*Organic Matter*	*Nitrogen*	*Phosphoric Acid*	*Disease Spread*
*Pequot	fair	good	h	vl	l	m	m	m
Dartmouth	good	good	m	m	l	m	m	s
*Oneida 1	good	fair	ml	l	l	m	vl	s
*Oneida 2	good	fair	m	vl	l	ml	vl	s
*Oneida 3	good	r thin	vl	vl	l	l	vl	s
*Virginia	fair	r thin	h	vl	l	l	mh	s
Cayuga	excellent	good	h	l	l	m	m	s
Navajo	excellent	good	h	lm	l	m	mh	
Dartmouth 2	good	fair	h	l	l	m	m	
*Navajo 2	poor	good	l	vl	l	m	m	s
*York 1	poor	r thin	l	vl	vl	vl	vl	s
*York 2	fair–poor	r thin	vl	l	l	l	l	s
*Toltec	fair–poor	thin	m	l	vl	l	vl	m
Quirigua	good	good	h	l	l	ml	m	

Aztec	good	good	m	l	vl	m
Nahua	fair	good	h	l	ml	hm
Puebla	fair	fair	h	l	l	m
Tehuana	good	fair	h	¶	l	m
Quiche 1	r poor	thin	h	l	vl	vl
Yuma	good	good	h	l	l	l
*Seminole	poor	thin	h	l	l	ml
Cherokee	poor	r thin	ml	vl	l	ml
Chickasaw	good	good	h	m	ml	mh
Choctaw	good	fair	m	l	vl	l
Oneida 4	good	good	h	l	l	ml
*Oneida 5	good	good	h	l	l	ml
*Oneida 6	fair	fair	h	vl	l	l
*Oneida 7	fair	fair	l	l	l	ml
Mixco	fair	fair	m	vl	l	l
*Sioux	–	good	h	l	m	m
Comanche	–	fair	h	m	m	m
Sacramento	woodland	fair	h	l	l	vl
Central Lands	woodland	fair	h	l	vl	l
Plietas	woodland	r thin	m	l	vl	vl
*Apache	–	fair	h	l	l	m
*Quiche	–	r thin	m	vl	l	m
*Quiche	–	r thin	m	l	l	m
Quiche	–	r thin	vl	vl	l	l
*Quiche	–	r thin	l	vl	vl	l

Aztec	m	
Nahua	m	
Puebla	m	
Tehuana	m	
Quiche 1	m	
Yuma	m	
*Seminole	m	
Cherokee	l	r
Chickasaw	m	high iron
Choctaw	m	s
Oneida 4	m	
*Oneida 5	m	s
*Oneida 6	l	s
*Oneida 7	vl	s
Mixco	vl	mr
*Sioux	l	
Comanche	m	
Sacramento	l	
Central Lands	l	
Plietas	l	
*Apache	h	
*Quiche	l	
*Quiche	l	
Quiche	ml	
*Quiche	l	

HONDURAS DIVISION

The Honduras Division comprises an area lying along the Caribbean Sea and is made up essentially of the valleys of two rivers, the Colorado and the Ulua, with the coastal plain and low hill lands lying between. It is supposed to be of the Cretaceous period and to be made up largely of basic lavas which have been disintegrated. The rivers are subject to rapid rise, particularly the Colorado, and sometimes overflow the surrounding country. The farms in the Colorado District are especially liable to flooding, but owing to the swiftness of the flow the deposition of silt is reported to be very slight. Most of these lands, however, show evidence of water deposition and the high percentage of silt and clay indicates that this process has gone on in the past in a large degree and it probably still takes place at certain stages of flood.

Mechanical Analysis. The soils of this Division show considerable variation in the physical character. Those in the Colorado District show some sand, mostly fine, and very little gravel. They are, however, very high in silt and in the still finer fraction designated as clay. The clay figures are low on the whole, except in the Ulua River District. San Alejos and Port Arturo show some gravel and coarse sand and a lower silt figure than the Colorado Valley. The mechanical analysis differs greatly from that of Guatemala and is quite comparable to that of Colombia.

Chemical Examination. The Division is characterized by a fairly high percentage of total potash. The percentage of lime in the upper Ulua Valley is highly satisfactory, but in other parts of the Division the average is rather low. The lime-magnesia ratio is generally satisfactory, except in the

Colorado District, where the magnesia tends to exceed the lime. A low organic matter figure is obtained for the whole Division and there is also a low content of total nitrogen, the ratios being in general much lower than is regarded as satisfactory. The phosphoric acid content is the same as Guatemala and lower than any of the other districts. It is about half that of the Panama Division. The following tables give the ratios of lime to magnesia and the ratios of organic matter to nitrogen.

HONDURAS DIVISION

SERIAL NUMBER *301*

Location: *Indiana* Farm, Section *15*. Date: *September, 1916.*

Other distinguishing features: *Area of poor plants.* Collector: *L. W. W.*

NATURAL FEATURES

Topography: *Valley.*
Drainage: *Fair, natural.*
Flood conditions: *Seldom.*
Silt deposition: *None.*
Type of forest growth: *Heavy.*

CULTIVATION HISTORY

When cleared and planted: *1915.*
Number of replantings: *None.* Why?
General condition when in production: *Good.*
Plowed? *No.* When? Grubbed? *No.* When?
Years in bananas: *One.* Life of farm: *In bearing October, 1916.*
Years in bush or fallow: *Never.*
Other crops grown: *None.*

DISEASE HISTORY

When first noted: *No Panama Disease; Colorado, Bud Rot and Big Foot Diseases present.*
Age of plants when attacked: *In 1916, plants one year old.*
Rapidity of spread: *Slow.*
Treatment given: *Digging out.*

OTHER DATA

	Surface—6"	6"—18"	18"—30"
Physical Examination			
Color	dark brown	light brown	red brown
Compactness	loose	loose	loose
Friability	light	light	light
Retentive power	77	72	69
Mechanical Examination			
Coarse gravel	0	0	0
Fine gravel	0	0	0
Coarse sand	0	0	0
Fine sand	0	0	0.2
Silt	95.5	96.1	96.4
Clay	4.5	3.9	3.4
Chemical Examination			
Organic matter	10.65	10.53	7.36
Total Nitrogen	.36	.17	.09
Potash (K_2O)	.54	.44	.19
Phosphoric acid (P_2O_5)	.06	.14	.10
Lime (CaO)	1.02	.60	.32
Magnesia (MgO)	1.37	1.33	.62
Iron (Fe_2O_3)	9.47	6.38	6.53
Alumina (Al_2O_3)			
Silica, sol. (SiO_2)			
Free Acidity			
Mycological Examination			
Typical Fusaria	No Panama Disease present		
Other Fusaria	Colorado Disease present Bud Rot and Big Foot present		

HONDURAS DIVISION

SERIAL NUMBER *302*

Location: *Indiana* Farm, Section *8*. Date: *September, 1916.*

Other distinguishing features: *Poor growth, wet land.* Collector: *L. W. W.*

NATURAL FEATURES

Topography: *Valley.*
Drainage: *Poor.*
Flood conditions: *Frequent.*
Silt deposition: *None.*
Type of forest growth: *Few large trees.*

CULTIVATION HISTORY

When cleared and planted: *1914.*
Number of replantings: *None.* Why?
General condition when in production: *Poor.*
Plowed? *No.* When? Grubbed? *No.* When?
Years in bananas: *Two.* Life of farm: *Draining would improve.*
Years in bush or fallow: *Never.*
Other crops grown: *None.*

DISEASE HISTORY

When first noted: *None.*
Age of plants when attacked:
Rapidity of spread:
Treatment given:

OTHER DATA

	Surface—6"	6"—18"	18"—30"
Physical Examination			
Color	dark brown	light brown	light brown
Compactness	hard	hard	hard
Friability	refractory	refractory	refractory
Retentive power	90	71	70
Mechanical Examination			
Coarse gravel	0	0	0
Fine gravel	0	0	0
Coarse sand	0	0	0
Fine sand	0	0	0
Silt	94.8	96.4	94.6
Clay	5.2	3.6	5.4
Chemical Examination			
Organic matter	6.13	8.76	7.68
Total Nitrogen	.32	.10	.10
Potash (K_2O)	.39	.40	.13
Phosphoric acid (P_2O_5)	.12	.12	.08
Lime (CaO)	.85	.53	.26
Magnesia (MgO)	1.36	1.27	.99
Iron (Fe_2O_3)	9.14	6.46	6.35
Alumina (Al_2O_3)			
Silica, sol. (SiO_2)			
Free Acidity			
Mycological Examination			
Typical Fusaria	No disease present		
Other Fusaria			

HONDURAS DIVISION

SERIAL NUMBER *303*

Location: *Dakota* Farm, Section *2*.

Date: *September, 1916.*

Other distinguishing features: *Bridgefoot.*

Collector: *L. W. W.*

NATURAL FEATURES

Topography: *Bottom land.*
Drainage: *Good, natural.*
Flood conditions: *Frequent.*
Silt deposition: *Heavy.*
Type of forest growth: *Scattered large trees, bamboo.*

CULTIVATION HISTORY

When cleared and planted: *1913.*
Number of replantings: *None.* Why?
General condition when in production: *Excellent.*
Plowed? *No.* When? Grubbed? *No.* When?
Years in bananas: *Three.* Life of farm: *Producing well.*
Years in bush or fallow: *Never.*
Other crops grown: *None.*

DISEASE HISTORY

When first noted: *No Panama Disease; Colorado, Bud Rot and Big Foot Diseases nearby.*
Age of plants when attacked: *Noted in 1913, plants three years old.*
Rapidity of spread: *Slow.*
Treatment given: *Digging out.*

OTHER DATA

	Surface—6"	6"—18"	18"—30"
Physical Examination			
Color	dark brown	light brown	light brown
Compactness	loose	loose	loose
Friability	light	light	light
Retentive power	50	33	41
Mechanical Examination			
Coarse gravel	0	0	0
Fine gravel	0	0	0
Coarse sand	0	1.7	8.1
Fine sand	3.4	43.0	90.4
Silt	95.2	54.9	1.5
Clay	1.4	.4	
Chemical Examination			
Organic matter	5.63	2.41	4.53
Total Nitrogen	.01	.04	.05
Potash (K_2O)	.61	.17	.26
Phosphoric acid (P_2O_5)	.13	.10	.14
Lime (CaO)	1.09	.55	.61
Magnesia (MgO)	1.07	.59	.62
Iron (Fe_2O_3)	7.42	4.74	5.51
Alumina (Al_2O_3)			
Silica, sol. (SiO_2)			
Free Acidity			
Mycological Examination			
Typical Fusaria	No Panama Disease present		
Other Fusaria	Colorado Disease present Bud Rot and Big Foot present		

HONDURAS DIVISION

SERIAL NUMBER *304*

Location: *Sisama* Farm, Section *28*. Date: *September, 1916.*

Other distinguishing features: *Opposite railroad siding.* Collector: *L. W. W.*

NATURAL FEATURES

Topography: *Valley.*
Drainage: *Poor.*
Flood conditions: *Frequent.*
Silt deposition: *None.*
Type of forest growth: *Heavy.*

CULTIVATION HISTORY

When cleared and planted: *1914.*
Number of replantings: *None.* Why?
General condition when in production: *Poor.*
Plowed? *No.* When? Grubbed? *No.* When?
Years in bananas: *Two.* Life of farm: *Drainage would improve.*
Years in bush or fallow: *Never.*
Other crops grown: *None.*

DISEASE HISTORY

When first noted: *None.*
Age of plants when attacked:
Rapidity of spread:
Treatment given:

OTHER DATA

	Surface—6"	6"—18"	18"—30"
Physical Examination			
Color	brown	light brown	light brown
Compactness	hard	hard	hard
Friability	refractory	refractory	refractory
Retentive power	80	65	60
Mechanical Examination			
Coarse gravel	0	0	0
Fine gravel	0	0	0
Coarse sand	0	0	0
Fine sand	0	0.8	12.9
Silt	95.1	95.6	84.9
Clay	4.9	4.6	2.2
Chemical Examination			
Organic matter	15.35	8.72	5.38
Total Nitrogen	.08	.10	.07
Potash (K_2O)	.59	.46	.17
Phosphoric acid (P_2O_5)	.08	.07	.08
Lime (CaO)	1.44	.71	.40
Magnesia (MgO)	1.00	1.32	.48
Iron (Fe_2O_3)	7.70	6.42	5.11
Alumina (Al_2O_3)			
Silica, sol. (SiO_2)			
Free Acidity			
Mycological Examination			
Typical Fusaria	No Panama Disease present		
Other Fusaria			

HONDURAS DIVISION

SERIAL NUMBER *305*

Location: *Alabama* Farm, Section *16*.
Other distinguishing features: *Back of motor shed.*

Date: *September, 1916.*
Collector: *L. W. W.*

NATURAL FEATURES

Topography: *Valley.*
Drainage: *Fair, artificial.*
Flood conditions: *Seldom.*
Silt deposition: *None.*
Type of forest growth: *Heavy.*

CULTIVATION HISTORY

When cleared and planted: *1914.*
Number of replantings: *None.* Why?
General condition when in production: *Poor.*
Plowed? *No.* When? Grubbed? *No.* When?
Years in bananas: *Two.* Life of farm: *Drainage would improve.*
Years in bush or fallow: *Never.*
Other crops grown: *None.*

DISEASE HISTORY

When first noted: *None.*
Age of plants when attacked:
Rapidity of spread:
Treatment given:

OTHER DATA

	Surface—6"	6"—18"	18"—30"
Physical Examination			
Color	brown	light brown	light brown
Compactness	hard	hard	hard
Friability	refractory	refractory	refractory
Retentive power	67	55	43
Mechanical Examination			
Coarse gravel	0	0	0
Fine gravel	0	0	0
Coarse sand	0	0	0
Fine sand	0	0.2	0.4
Silt	96.2	98.0	97.7
Clay	3.8	1.8	1.9
Chemical Examination			
Organic matter	6.89	6.00	5.47
Total Nitrogen	.01	.07	0
Potash (K_2O)	.60	.27	.87
Phosphoric acid (P_2O_5)	.10	.10	.52
Lime (CaO)	.62	.65	.69
Magnesia (MgO)	1.41	.52	.83
Iron (Fe_2O_3)	8.81	6.38	6.44
Alumina (Al_2O_3)			
Silica, sol. (SiO_2)			
Free Acidity			
Mycological Examination			
Typical Fusaria	No Panama Disease present		
Other Fusaria			

HONDURAS DIVISION

SERIAL NUMBER *306*

Location: *California* Farm, Section *29*.

Date: *September, 1916.*

Collector: *L. W. W.*

Other distinguishing features:

NATURAL FEATURES

Topography: *Valley.*
Drainage: *Poor.*
Flood conditions: *Frequent.*
Silt deposition: *None.*
Type of forest growth: *Heavy.*

CULTIVATION HISTORY

When cleared and planted: *1914.*
Number of replantings: *None.* Why?
General condition when in production: *Poor.*
Plowed? *No.* When? Grubbed? *No.* When?
Years in bananas: *Two.* Life of farm: *Drainage would improve.*
Years in bush or fallow: *Never.*
Other crops grown: *None.*

DISEASE HISTORY

When first noted: *None.*
Age of plants when attacked:
Rapidity of spread:
Treatment given:

OTHER DATA

	Surface—6"	6"—18"	18"—30"
Physical Examination			
Color	brown	light brown	light brown
Compactness	hard	hard	hard
Friability	refractory	refractory	refractory
Retentive power	82	72	68
Mechanical Examination			
Coarse gravel	0	0	0
Fine gravel	0	0	0
Coarse sand	0	0	0
Fine sand	0	0	0
Silt	95.7	97.3	96.8
Clay	4.3	2.7	3.2
Chemical Examination			
Organic matter	11.62	8.02	6.25
Total Nitrogen	.21	.11	.11
Potash (K_2O)	.45	.19	.14
Phosphoric acid (P_2O_5)	.19	.10	.09
Lime (CaO)	.73	.43	.36
Magnesia (MgO)	.94	.81	.39
Iron (Fe_2O_3)	7.08	6.85	6.45
Alumina (Al_2O_3)			
Silica, sol. (SiO_2)			
Free Acidity			
Mycological Examination			
Typical Fusaria	No Panama Disease present		
Other Fusaria			

HONDURAS DIVISION

SERIAL NUMBER *307*

Location: *Ceibita* Farm, Section *2.*

Date: *September, 1916.*

Collector:

Other distinguishing features:

NATURAL FEATURES

Topography: *Bottom land.*
Drainage: *Fair, natural.*
Flood conditions: *Yearly.*
Silt deposition: *Light.*
Type of forest growth: *Heavy.*

CULTIVATION HISTORY

When cleared and planted: *Before 1913.*
Number of replantings: *None.* Why?
General condition when in production: *Good.*
Plowed? *No.* When? Grubbed? *No.* When?
Years in bananas: *Four or more.* Life of farm: *Good producer.*
Years in bush or fallow: *Never.*
Other crops grown: *None.*

DISEASE HISTORY

When first noted: *None.*
Age of plants when attacked:
Rapidity of spread:
Treatment given:

OTHER DATA

	Surface—6"	6"—18"	18"—30"
Physical Examination			
Color	brown	light brown	light brown
Compactness	loose	loose	loose
Friability	light	light	light
Retentive power	80	65	57
Mechanical Examination			
Coarse gravel	0	0	0
Fine gravel	0	0	0
Coarse sand	0	0	0
Fine sand	0	0	0.2
Silt	94.8	96.2	96.7
Clay	5.2	3.8	3.1
Chemical Examination			
Organic matter	12.61	7.75	7.15
Total Nitrogen	.01	.11	.10
Potash (K_2O)	.62	.19	.14
Phosphoric acid (P_2O_5)	.12	.20	.13
Lime (CaO)	2.14	.97	1.24
Magnesia (MgO)	1.44	.95	.62
Iron (Fe_2O_3)	8.73	7.28	4.67
Alumina (Al_2O_3)			
Silica, sol. (SiO_2)			
Free Acidity			
Mycological Examination			
Typical Fusaria	No Panama Disease present		
Other Fusaria			

HONDURAS DIVISION

SERIAL NUMBER *308*

Location: *Uluasito* Farm, Section ; *Last toward woodland.* Date: *September, 1916.*

Other distinguishing features: Collector: *L. W. W.*

NATURAL FEATURES

Topography: *Bottom land.*
Drainage: *Fair, natural.*
Flood conditions: *Yearly.*
Silt deposition: *Light.*
Types of forest growth: *Few large trees and bamboo.*

CULTIVATION HISTORY

When cleared and planted: *1913.*
Number of replantings: *None.* Why?
General condition when in production: *Good.*
Plowed? *No.* When? Grubbed? *No.* When?
Years in bananas: *Three.* Life of farm: *None shipped, railroad not completed.*
Years in bush or fallow: *Never.*
Other crops grown: *None.*

DISEASE HISTORY

When first noted: *None.*
Age of plants when attacked:
Rapidity of spread:
Treatment given:

OTHER DATA

	Surface—6"	6"—18"	18"—30"
Physical Examination			
Color	dark brown	light brown	rocks
Compactness	loose	loose	rocks
Friability	light	light	rocks
Retentive power	65	35	0
Mechanical Examination			
Coarse gravel	0	0	0
Fine gravel	0	0	0
Coarse sand	0	0	0
Fine sand	0.4	28.7	0
Silt	97.0	1.3	0
Clay	2.6		
Chemical Examination			
Organic matter	9.45	4.75	rocks
Total Nitrogen	.24	.09	rocks
Potash (K_2O)	.10	.18	rocks
Phosphoric acid (P_2O_5)	.15	.21	rocks
Lime (CaO)	.57	.76	rocks
Magnesia (MgO)	.69	.91	rocks
Iron (Fe_2O_3)	6.90	5.90	rocks
Alumina (Al_2O_3)			
Silica, sol. (SiO_2)			
Free Acidity			
Mycological Examination			
Typical Fusaria	No Panama Disease present		
Other Fusaria			

HONDURAS DIVISION

SERIAL NUMBER *309*

Location: *Uluasito* Farm, Section ; *Woodland.* Date: *September, 1916.*

Other distinguishing features: Collector: *L. W. W.*

NATURAL FEATURES

Topography: *Bottom land.*
Drainage: *Fair, natural.*
Flood conditions: *Yearly.*
Silt deposition: *Light.*
Type of forest growth: *Large trees and bamboo.*

CULTIVATION HISTORY

When cleared and planted: *Virgin woodland.*
Number of replantings: Why?
General condition when in production:
Plowed? When? Grubbed? When?
Years in bananas: Life of farm:
Years in bush or fallow:
Other crops grown:

DISEASE HISTORY

When first noted: *None.*
Age of plants when attacked:
Rapidity of spread:
Treatment given:

OTHER DATA

	Surface—6"	6"—18"	18"—30"
Physical Examination			
Color	brown	light brown	light brown
Compactness	loose	loose	loose
Friability	light	light	light
Retentive power	71	59	64
Mechanical Examination			
Coarse gravel	0	0	0
Fine gravel	0	0	0
Coarse sand	0	0	0
Fine sand	0	0	0.3
Silt	96.5	94.6	96.6
Clay	3.5	5.4	3.1
Chemical Examination			
Organic matter	7.38	5.93	5.56
Total Nitrogen	.09	.08	.08
Potash (K_2O)	.48	.16	.24
Phosphoric acid (P_2O_5)	.24	.18	.21
Lime (CaO)	.91	.41	.69
Magnesia (MgO)	1.33	.58	1.25
Iron (Fe_2O_3)	9.91	7.00	8.04
Alumina (Al_2O_3)			
Silica, sol. (SiO_2)			
Free Acidity			
Mycological Examination			
Typical Fusaria	No Panama Disease present		
Other Fusaria			

HONDURAS DIVISION

SERIAL NUMBER *310*

Location: *El Eden* Farm, Section ; *By ballast pit.* Date: *September, 1916.*

Other distinguishing features: Collector: *L. W. W.*

NATURAL FEATURES

Topography: *Hillside.*
Drainage: *Good.*
Flood conditions: *Never.*
Silt deposition: *None.*
Type of forest growth: *Large timber and bamboo.*

CULTIVATION HISTORY

When cleared and planted: *1913.*
Number of replantings: *None.* Why?
General condition when in production: *Good.*
Plowed? *No.* When? Grubbed? *No.* When?
Years in bananas: *Three.* Life of farm: *None shipped, railroad not completed.*
Years in bush or fallow: *Never.*
Other crops grown: *None.*

DISEASE HISTORY

When first noted: *None.*
Age of plants when attacked:
Rapidity of spread:
Treatment given:

OTHER DATA

	Surface—6"	6"—18"	18"—30"
Physical Examination			
Color	dark brown	dark brown	red brown
Compactness	hard	hard	hard
Friability	refractory	refractory	refractory
Retentive power	62	60	57
Mechanical Examination			
Coarse gravel	0	0	0
Fine gravel	0	0.1	0
Coarse sand	0	0	0
Fine sand	2.1	1.1	3.5
Silt	92.7	94.7	93.3
Clay	5.2	4.1	3.2
Chemical Examination			
Organic matter	16.82	11.63	10.31
Total Nitrogen	.01	.11	0
Potash (K_2O)	.30	.17	.07
Phosphoric acid (P_2O_5)	.21	.16	.15
Lime (CaO)	.60	.24	.15
Magnesia (MgO)	.87	.12	.11
Iron (Fe_2O_3)	5.96	4.76	5.52
Alumina (Al_2O_3)			
Silica, sol. (SiO_2)			
Free Acidity			
Mycological Examination			
Typical Fusaria	No Panama Disease present		
Other Fusaria			

HONDURAS DIVISION

SERIAL NUMBER *311*

Location: *Estero Claro* Farm, Section *; By track and camps.* Date: *September, 1916.*

Other distinguishing features: Collector: *L. W. W.*

NATURAL FEATURES

Topography: *Valley.*
Drainage: *Fair, natural.*
Flood conditions: *Yearly.*
Silt deposition: *None.*
Type of forest growth: *Large timber and bamboo.*

CULTIVATION HISTORY

When cleared and planted: *1913.*
Number of replantings: *None.* Why?
General condition when in production: *Fair.*
Plowed? *No.* When? Grubbed? *No.* When?
Years in bananas: *Three.* Life of farm: *None shipped, railroad not completed.*
Years in bush or fallow: *Never.*
Other crops grown: *None.*

DISEASE HISTORY

When first noted: *None.*
Age of plants when attacked:
Rapidity of spread:
Treatment given:

OTHER DATA

	Surface—6"	6"—18"	18"—30"
Physical Examination			
Color	brown	light brown	gray
Compactness	loose	loose	loose
Friability	light	light	light
Retentive power	74	66	51
Mechanical Examination			
Coarse gravel	0	0	0
Fine gravel	0	0	0
Coarse sand	0	0	0
Fine sand	0	0	0.3
Silt	95.5	97.8	97.5
Clay	4.5	2.2	2.2
Chemical Examination			
Organic matter	13.05	8.13	4.83
Total Nitrogen	.01	.15	.08
Potash (K_2O)	.57	.21	.22
Phosphoric acid (P_2O_5)	.12	.27	.25
Lime (CaO)	.80	1.22	1.04
Magnesia (MgO)	.96	.62	.82
Iron (Fe_2O_3)	7.25	6.56	5.53
Alumina (Al_2O_3)			
Silica, sol. (SiO_2)			
Free Acidity			
Mycological Examination			
Typical Fusaria	No Panama Disease present		
Other Fusaria			

HONDURAS DIVISION

SERIAL NUMBER *312*

Location: *Zuniga* Farm, Section ; *Woodland.*

Date: *September, 1916.*

Other distinguishing features:

Collector: *L. W. W.*

NATURAL FEATURES

Topography: *Bottom land.*
Drainage: *Fair, natural.*
Flood conditions: *Yearly.*
Silt deposition: *Frequent, but moderate.*
Type of forest growth: *Bamboo and a few large trees.*

CULTIVATION HISTORY

When cleared and planted: *Virgin woodland.*
Number of replantings: Why?
General condition when in production:
Plowed: When? Grubbed? When?
Years in bananas: Life of farm:
Years in bush or fallow:
Other crops grown:

DISEASE HISTORY

When first noted:
Age of plants when attacked:
Rapidity of spread:
Treatment given:

OTHER DATA

	Surface—6"	6"—18"	18"—30"
Physical Examination			
Color	brown	light brown	light brown
Compactness	loose	loose	loose
Friability	light	light	light
Retentive power	55	45	28
Mechanical Examination			
Coarse gravel	0	0	0
Fine gravel	0	0	9.2
Coarse sand	0	0.2	11.9
Fine sand	0.3	3.4	17.0
Silt	98.3	94.8	59.3
Clay	1.4	1.6	2.6
Chemical Examination			
Organic matter	8.83	3.84	2.65
Total Nitrogen	.25	.10	.06
Potash (K_2O)	1.32	.45	.30
Phosphoric acid (P_2O_5)	.12	.17	.17
Lime (CaO)	.91	.62	.66
Magnesia (MgO)	1.20	.61	.66
Iron (Fe_2O_3)	6.76	6.76	7.83
Alumina (Al_2O_3)			
Silica, sol. (SiO_2)			
Free Acidity			
Mycological Examination			
Typical Fusaria	No Panama Disease present		
Other Fusaria			

HONDURAS DIVISION

SERIAL NUMBER *313*

Location: *Jilamo* Farm, Section *55*. Date: *September, 1916.*

Other distinguishing features: *By switch.* Collector: *L. W. W.*

NATURAL FEATURES

Topography: *Bottom land.*
Drainage: *Fair, natural.*
Flood conditions: *Yearly.*
Silt deposition: *Light.*
Type of forest growth: *Bamboo and a few trees.*

CULTIVATION HISTORY

When cleared and planted: *1916.*
Number of replantings: *None.* Why?
General condition when in production: *Good—bananas just shooting.*
Plowed? *No.* When? Grubbed? *No.* When?
Years in bananas: *One.* Life of farm: *Appearances indicate good producer.*
Years in bush or fallow: *Never.*
Other crops grown: *None.*

DISEASE HISTORY

When first noted: *None.*
Age of plants when attacked:
Rapidity of spread:
Treatment given:

OTHER DATA

	Surface—6"	6"—18"	18"—30"
Physical Examination			
Color	brown	light brown	light brown
Compactness	loose	loose	loose
Friability	light	light	light
Retentive power	69	62	56
Mechanical Examination			
Coarse gravel	0	0	0
Fine gravel	0	0	0
Coarse sand	0	0	0
Fine sand	0	0.3	0.9
Silt	97.3	96.2	96.5
Clay	2.7	3.5	2.6
Chemical Examination			
Organic matter	5.19	6.25	4.44
Total Nitrogen	.30	.12	.07
Potash (K_2O)	1.36	.36	.97
Phosphoric acid (P_2O_5)	.21	.25	.23
Lime (CaO)	.53	1.31	1.17
Magnesia (MgO)	1.48	1.24	.85
Iron (Fe_2O_3)	7.29	7.12	7.08
Alumina (Al_2O_3)			
Silica, sol. (SiO_2)			
Free Acidity			
Mycological Examination			
Typical Fusaria	No Panama Disease present		
Other Fusaria			

HONDURAS DIVISION

SERIAL NUMBER *314*

Location: *Arizona* Farm, Section *18*. Date: *September, 1916.*

Other distinguishing features: *Small knoll.* Collector: *L. W. W.*

NATURAL FEATURES

Topography: *Hilltop.*
Drainage: *Fair, natural.*
Flood conditions: *None.*
Silt deposition: *None.*
Type of forest growth: *Heavy.*

CULTIVATION HISTORY

When cleared and planted: *1913.*
Number of replantings: *None.* Why?
General condition when in production: *Poor.*
Plowed? *No.* When? Grubbed? *No.* When?
Years in bananas: *Three.* Life of farm: *This area poor.*
Years in bush or fallow: *Never.*
Other crops grown: *None.*

DISEASE HISTORY

When first noted: *No Panama Disease; but Colorado, Big Foot and Bud Rot Diseases in 1913.*
Age of plants when attacked: *In young plants.*
Rapidity of spread: *Slow.*
Treatment given: *Digging out.*

OTHER DATA

	Surface—6"	6"—18"	18"—30"
Physical Examination			
Color	brown	red brown	red brown
Compactness	hard	hard	hard
Friability	refractory	refractory	refractory
Retentive power	46	54	55
Mechanical Examination			
Coarse gravel	0	0	0
Fine gravel	1.4	3.4	0
Coarse sand	7.9	8.9	0
Fine sand	18.8	21.7	14.2
Silt	70.2	64.0	83.3
Clay	1.7	2.0	2.5
Chemical Examination			
Organic matter	5.83	5.90	8.12
Total Nitrogen	.21	.10	.09
Potash (K_2O)	1.36	.10	.14
Phosphoric acid (P_2O_5)	.05	.18	.17
Lime (CaO)	1.49	.17	.19
Magnesia (MgO)	.20	.05	.04
Iron (Fe_2O_3)	2.01	2.82	4.41
Alumina (Al_2O_3)			
Silica, sol. (SiO_2)			
Free Acidity			
Mycological Examination			
Typical Fusaria	No Panama Disease present		
Other Fusaria	Colorado Disease present Bud Rot and Big Foot present		

HONDURAS DIVISION

SERIAL NUMBER *315*

Location: *Las Palmas* Farm, Section *9*. Date: *September, 1916.*

Other distinguishing features: *Across river from house.* Collector: *L. W. W.*

NATURAL FEATURES

Topography: *Bottom land.*
Drainage: *Good, natural.*
Flood conditions: *Seldom.*
Silt deposition: *Heavy.*
Type of forest growth: *Heavy.*

CULTIVATION HISTORY

When cleared and planted: *Before 1912.*
Number of replantings: *None.* Why?
General condition when in production: *Good.*
Plowed? *No.* When? Grubbed? *No.* When?
Years in bananas: *Four or more.* Life of farm: *Good producer.*
Years in bush or fallow: *Never.*
Other crops grown: *None.*

DISEASE HISTORY

When first noted: *None.*
Age of plants when attacked:
Rapidity of spread:
Treatment given:

OTHER DATA

	Surface—6"	6"—18"	18"—30"
Physical Examination			
Color	brown	light brown	light brown
Compactness	loose	loose	loose
Friability	light	light	light
Retentive power	83	45	70
Mechanical Examination			
Coarse gravel	0	0	0
Fine gravel	0	0	0
Coarse sand	0	2.0	0
Fine sand	0.8	30.3	1.2
Silt	95.2	66.1	95.2
Clay	4.0	1.6	3.6
Chemical Examination			
Organic matter	12.10	3.90	6.77
Total Nitrogen	.02	.10	.10
Potash (K_2O)	.05	1.00	1.05
Phosphoric acid (P_2O_5)	.41	.11	.38
Lime (CaO)	1.94	.91	.77
Magnesia (MgO)	1.80	.88	1.27
Iron (Fe_2O_3)	4.36	4.70	6.11
Alumina (Al_2O_3)			
Silica, sol. (SiO_2)			
Free Acidity			
Mycological Examination			
Typical Fusaria	No Panama Disease present		
Other Fusaria			

HONDURAS DIVISION

SERIAL NUMBER *316*

Location: *San Alejos* Farm, Section ; *By river and trail.*

Date: *October, 1916.*

Other distinguishing features:

Collector: *L. W. W.*

NATURAL FEATURES

Topography: *Valley.*
Drainage: *Good.*
Flood conditions: *Yearly.*
Silt deposition: *About an inch.*
Type of forest growth: *Heavy manaca.*

CULTIVATION HISTORY

When cleared and planted: *Virgin woodland.*
Number of replantings: Why?
General condition when in production:
Plowed? When? Grubbed? When?
Years in bananas: Life of farm:
Years in bush or fallow:
Other crops grown:

DISEASE HISTORY

When first noted: *None.*
Age of plants when attacked:
Rapidity of spread:
Treatment given:

OTHER DATA

	Surface—6"	6"—18"	18"—30"
PHYSICAL EXAMINATION			
Color	brown	gray	gray
Compactness	loose	loose	loose
Friability	light	light	light
Retentive power	47	33	33
MECHANICAL EXAMINATION			
Coarse gravel	0	0	0
Fine gravel	10.0	0	0
Coarse sand	17.6	1.5	2.3
Fine sand	18.0	26.4	16.4
Silt	52.5	69.5	78.7
Clay	1.9	2.6	2.6
CHEMICAL EXAMINATION			
Organic matter	4.78	3.40	3.23
Total Nitrogen	.20	.05	.04
Potash (K_2O)	.62	.44	.37
Phosphoric acid (P_2O_5)	.33	.08	.07
Lime (CaO)	1.74	.58	.58
Magnesia (MgO)	3.15	.92	.94
Iron (Fe_2O_3)	7.11	4.49	3.90
Alumina (Al_2O_3)			
Silica, sol. (SiO_2)			
Free Acidity			
MYCOLOGICAL EXAMINATION			
Typical Fusaria	No Panama Disease present		
Other Fusaria			

HONDURAS DIVISION

SERIAL NUMBER *317*

Location: *San Alejos* Farm, Section ; *By old patch of red bananas.* Date: *October, 1916.*
Other distinguishing features: Collector: *L. W. W.*

NATURAL FEATURES

Topography: *Valley.*
Drainage: *Good.*
Flood conditions: *Yearly.*
Silt deposition: *About an inch.*
Type of forest growth: *Manaca.*

CULTIVATION HISTORY

When cleared and planted: *Virgin woodland.*
Number of replantings: Why?
General condition when in production:
Plowed? When? Grubbed? When?
Years in bananas: Life of farm:
Years in bush or fallow:
Other crops grown:

DISEASE HISTORY

When first noted: *None.*
Age of plants when attacked:
Rapidity of spread:
Treatment given:

OTHER DATA

This small patch of red bananas was planted by some one about six years ago.

	Surface—6"	6"—18"	18"—30"
Physical Examination			
Color	dark brown	light brown	red brown
Compactness	loose	loose	loose
Friability	light	light	light
Retentive power	86	62	57
Mechanical Examination			
Coarse gravel	0	0	0
Fine gravel	14.8	0	0
Coarse sand	4.5	0.5	6.2
Fine sand	25.6	1.3	90.8
Silt	50.8	94.7	3.0
Clay	4.3	3.5	
Chemical Examination			
Organic matter	13.79	6.97	5.67
Total Nitrogen	.01	.15	.10
Potash (K_2O)	.40	.51	.45
Phosphoric acid (P_2O_5)	.43	.34	.13
Lime (CaO)	2.01	1.30	1.10
Magnesia (MgO)	1.00	.96	1.13
Iron (Fe_2O_3)	8.29	4.49	6.93
Alumina (Al_2O_3)			
Silica, sol. (SiO_2)			
Free Acidity			
Mycological Examination			
Typical Fusaria	No Panama Disease present		
Other Fusaria			

HONDURAS DIVISION

SERIAL NUMBER *318*

Location: *San Alejos* Farm, Section ; *Between trail and river.* Date: *October, 1916.*

Other distinguishing features: Collector: *L. W. W.*

NATURAL FEATURES

Topography: *Valley.*
Drainage: *Good.*
Flood conditions: *Yearly.*
Silt deposition: *About an inch.*
Type of forest growth: *Manaca.*

CULTIVATION HISTORY

When cleared and planted: *Virgin woodland.*
Number of replantings: Why?
General condition when in production:
Plowed? When? Grubbed? When?
Years in bananas: Life of farm:
Years in bush or fallow:
Other crops grown:

DISEASE HISTORY

When first noted: *None.*
Age of plants when attacked:
Rapidity of spread:
Treatment given:

OTHER DATA

	Surface—6"	6"—18"	18"—30"
Physical Examination			
Color	light brown	brown	brown
Compactness	loose	loose	loose
Friability	light	light	light
Retentive power	72	70	61
Mechanical Examination			
Coarse gravel	0	0	0
Fine gravel	0	0	7.0
Coarse sand	0	0	3.1
Fine sand	0	1.1	14.2
Silt	96.9	96.2	1.7
Clay	3.1	2.7	
Chemical Examination			
Organic matter	10.48	7.46	4.95
Total Nitrogen	.27	.17	.09
Potash (K_2O)	.05	.26	1.06
Phosphoric acid (P_2O_5)	.39	.15	.22
Lime (CaO)	1.59	.90	.59
Magnesia (MgO)	.78	1.04	.95
Iron (Fe_2O_3)	7.19	6.62	4.93
Alumina (Al_2O_3)			
Silica, sol. (SiO_2)			
Free Acidity			
Mycological Examination			
Typical Fusaria	No Panama Disease present		
Other Fusaria			

HONDURAS DIVISION

SERIAL NUMBER *319*

Location: *San Alejos* Farm, Section ; *Between river and railroad.*

Date: *October, 1916.*

Collector: *L. W. W.*

Other distinguishing features:

NATURAL FEATURES

Topography: *Valley.*
Drainage: *Good.*
Flood conditions: *Yearly or oftener.*
Silt deposition: *About an inch.*
Type of forest growth: *Manaca.*

CULTIVATION HISTORY

When cleared and planted: *Virgin woodland.*
Number of replantings: Why?
General condition when in production:
Plowed? When? Grubbed? When?
Years in bananas: Life of farm:
Years in bush or fallow:
Other crops grown:

DISEASE HISTORY

When first noted:
Age of plants when attacked:
Rapidity of spread:
Treatment given:

OTHER DATA

	Surface—6"	6"—18"	18"—30"
Physical Examination			
Color	light brown	brown	brown
Compactness	loose	loose	loose
Friability	light	light	light
Retentive power	57	39	30
Mechanical Examination			
Coarse gravel	0	0	0
Fine gravel	0	0	3.1
Coarse sand	0	0	15.5
Fine sand	11.3	18.2	60.0
Silt	86.5	79.8	20.5
Clay	2.2	2.0	.9
Chemical Examination			
Organic matter	6.90	3.99	1.75
Total Nitrogen	.34	.06	.01
Potash (K_2O)	.48	1.59	.52
Phosphoric acid (P_2O_5)	.48	.11	.09
Lime (CaO)	1.04	.89	1.14
Magnesia (MgO)	1.10	1.14	.78
Iron (Fe_2O_3)	6.75	4.83	4.94
Alumina (Al_2O_3)			
Silica, sol. (SiO_2)			
Free Acidity			
Mycological Examination			
Typical Fusaria	No Panama Disease present		
Other Fusaria			

HONDURAS DIVISION

SERIAL NUMBER *320*

Location: *Esperanza* Farm, Section *18*. Date: *October, 1916.*

Other distinguishing features: *End of spur track.* Collector: *L. W. W.*

NATURAL FEATURES

Topography: *Valley.*
Drainage: *Fair.*
Flood conditions: *Yearly.*
Silt deposition: *About an inch.*
Type of forest growth: *Manaca.*

CULTIVATION HISTORY

When cleared and planted: *1904.*
Number of replantings: *One.* Why? *First bits failed.*
General condition when in production: *Good and later fair.*
Plowed? *No.* When? Grubbed? *No.* When?
Years in bananas: *Twelve.* Life of farm: *Still producing well.*
Years in bush or fallow: *One.*
Other crops grown: *None.*

DISEASE HISTORY

When first noted: *July, 1916, in another part of farm.*
Age of plants when attacked: *Twelve years.*
Rapidity of spread: *Slow.*
Treatment given: *Digging out, burning and bleaching.*

OTHER DATA

This farm was purchased from several small planters and made into one farm.

	Surface—6"	6"—18"	18"—30"
Physical Examination			
Color	brown	light brown	light brown
Compactness	loose	loose	loose
Friability	light	light	light
Retentive power	69	66	60
Mechanical Examination			
Coarse gravel	0	0	0
Fine gravel	0	0	0
Coarse sand	0	0	0
Fine sand	2.9	2.5	3.3
Silt	93.0	94.6	94.0
Clay	4.1	2.9	2.7
Chemical Examination			
Organic matter	11.06	8.10	6.83
Total Nitrogen	.43	.18	.09
Potash (K_2O)	.57	.35	.35
Phosphoric acid (P_2O_5)	.39	.13	.09
Lime (CaO)	.88	.55	.41
Magnesia (MgO)	.89	.63	.83
Iron (Fe_2O_3)	5.11	4.70	5.38
Alumina (Al_2O_3)			
Silica, sol. (SiO_2)			
Free Acidity			
Mycological Examination			
Typical Fusaria	Panama Disease present in farm		
Other Fusaria	Colorado Disease present in farm		

HONDURAS DIVISION

SERIAL NUMBER *321*

Location: *Esperanza* Farm, Section *38*.

Date: *October, 1916.*

Other distinguishing features: *Opposite house, by track.*

Collector: *L. W. W.*

NATURAL FEATURES

Topography: *Bottom land.*
Drainage: *Fair.*
Flood conditions: *Seldom.*
Silt deposition: *None.*
Type of forest growth: *Manaca.*

CULTIVATION HISTORY

When cleared and planted: *1907.*
Number of replantings: *One.* Why? *First bits failed.*
General condition when in production: *Good to bad.*
Plowed? *No.* When? Grubbed? *No.* When?
Years in bananas: *Nine.* Life of farm: *Production now only fair.*
Years in bush or fallow: *Two years.*
Other crops grown: *None.*

DISEASE HISTORY

When first noted: *July, 1916, in another part of farm.*
Age of plants when attacked: *Nine years.*
Rapidity of spread: *Slow.*
Treatment given: *Digging out, burning and bleaching.*

OTHER DATA

This farm was purchased from several small planters and made into one farm.

	Surface—6"	6"—18"	18"—30"
Physical Examination			
Color	dark brown	light brown	light brown
Compactness	loose	loose	loose
Friability	light	light	light
Retentive power	81	59	42
Mechanical Examination			
Coarse gravel	0	0	0
Fine gravel	0	0.1	0.2
Coarse sand	0	1.2	4.1
Fine sand	15.8	18.1	47.5
Silt	75.6	78.4	47.4
Clay	8.6	2.2	1.1
Chemical Examination			
Organic matter	16.71	5.03	3.06
Total Nitrogen	.58	.11	.07
Potash (K_2O)	.67	.39	.28
Phosphoric acid (P_2O_5)	.37	.11	.09
Lime (CaO)	1.62	.65	.78
Magnesia (MgO)	.63	.95	.81
Iron (Fe_2O_3)	3.85	4.51	4.34
Alumina (Al_2O_3)			
Silica, sol. (SiO_2)			
Free Acidity			
Mycological Examination			
Typical Fusaria	Panama Disease present in farm		
Other Fusaria	Colorado Disease present in farm		

HONDURAS DIVISION

SERIAL NUMBER *322*

Location: *Agua Blanca* Farm, Section *; By road to house, near track.*

Date: *October, 1916.*
Collector: *L. W. W.*

Other distinguishing features:

NATURAL FEATURES
- Topography: *Valley.*
- Drainage: *Good.*
- Flood conditions: *Yearly.*
- Silt deposition: *About an inch.*
- Type of forest growth: *Manaca.*

CULTIVATION HISTORY
- When cleared and planted: *1910.*
- Number of replantings: *One.* Why? *First bits failed.*
- General condition when in production: *Good.*
- Plowed? *No.* When? Grubbed? *No.* When?
- Years in bananas: *Six.* Life of farm: *Producing well.*
- Years in bush or fallow: *Never.*
- Other crops grown: *None.*

DISEASE HISTORY
- When first noted: *August, 1916, in another part of farm.*
- Age of plants when attacked: *Six years.*
- Rapidity of spread: *Slow.*
- Treatment given: *Digging out, burning and bleaching.*

OTHER DATA
This farm was purchased from Hubbard-Zemurray.

	Surface—6"	6"—18"	18"—30"
Physical Examination			
Color	light brown	light brown	light brown
Compactness	loose	loose	loose
Friability	light	light	light
Retentive power	60	82	71
Mechanical Examination			
Coarse gravel	0	0	0
Fine gravel	0	0	0
Coarse sand	1.3	0	0
Fine sand	28.0	3.0	7.6
Silt	67.2	94.0	90.3
Clay	3.5	3.0	2.1
Chemical Examination			
Organic matter	8.29	6.83	6.23
Total Nitrogen	.03	.11	.08
Potash (K_2O)	.69	.56	.64
Phosphoric acid (P_2O_5)	.12	.10	.08
Lime (CaO)	.49	1.13	1.12
Magnesia (MgO)	.70	1.07	.87
Iron (Fe_2O_3)	5.28	8.75	7.51
Alumina (Al_2O_3)			
Silica, sol. (SiO_2)			
Free Acidity			
Mycological Examination			
Typical Fusaria	Panama Disease in farm		
Other Fusaria	Colorado Disease in farm		

HONDURAS DIVISION

SERIAL NUMBER *323*

Location: *Uluita* Farm, Section *3*.

Date: *October, 1916.*

Other distinguishing features:

Collector: *L. W. W.*

NATURAL FEATURES

Topography: *Bottom land.*
Drainage: *Fair.*
Flood conditions: *Yearly.*
Silt deposition: *About one inch.*
Type of forest growth: *Manaca.*

CULTIVATION HISTORY

When cleared and planted: *1907.*
Number of replantings: *One.* Why? *First bits failed.*
General condition when in production: *Good.*
Plowed? *No.* When? Grubbed? *No.* When?
Years in bananas: *Nine.* Life of farm: *Production still good.*
Years in bush or fallow: *Two.*
Other crops grown: *None.*

DISEASE HISTORY

When first noted: *None.*
Age of plants when attacked:
Rapidity of spread:
Treatment given:

OTHER DATA

Farm was purchased from Tela Fruit Company.

	Surface—6"	6"—18"	18"—30"
Physical Examination			
Color	dark brown	light brown	light brown
Compactness	loose	loose	loose
Friability	light	light	light
Retentive power	89	68	64
Mechanical Examination			
Coarse gravel	0	0	0
Fine gravel	0	0	0
Coarse sand	0	0	0
Fine sand	0.5	0.6	0.9
Silt	95.0	95.7	95.8
Clay	4.5	3.7	3.3
Chemical Examination			
Organic matter	12.61	6.00	7.17
Total Nitrogen	.33	.07	.14
Potash (K_2O)	1.55	1.03	.39
Phosphoric acid (P_2O_5)	.16	.11	.13
Lime (CaO)	1.22	.99	.76
Magnesia (MgO)	1.15	1.09	.33
Iron (Fe_2O_3)	5.72	6.66	7.89
Alumina (Al_2O_3)			
Silica, sol. (SiO_2)			
Free Acidity			
Mycological Examination			
Typical Fusaria	No Panama Disease present		
Other Fusaria	No Colorado Disease present		

HONDURAS DIVISION

SERIAL NUMBER *324*

Location: *Fortuna* Farm, Section ; *Half way down old spur.* Date: *October, 1916.*

Other distinguishing features: Collector: *L. W. W.*

NATURAL FEATURES

Topography: *Valley.*
Drainage: *Good.*
Flood conditions: *Yearly.*
Silt deposition: *About a half inch.*
Type of forest growth: *Manaca.*

CULTIVATION HISTORY

When cleared and planted: *1900.*
Number of replantings: *One.* Why? *First bits failed.*
General condition when in production: *Good.*
Plowed? *No.* When? Grubbed? *No.* When?
Years in bananas: *Sixteen.* Life of farm: *Now abandoned.*
Years in bush or fallow: *Three months.*
Other crops grown: *None.*

DISEASE HISTORY

When first noted: *None.*
Age of plants when attacked:
Rapidity of spread:
Treatment given:

OTHER DATA

Purchased from Hubbard-Zemurray.

	Surface—6"	6"—18"	18"—30"
Physical Examination			
Color	dark brown	light brown	brown
Compactness	loose	loose	loose
Friability	light	light	light
Retentive power	71	48	37
Mechanical Examination			
Coarse gravel	0	0	0
Fine gravel	0	0	0
Coarse sand	0	0.1	0
Fine sand	15.2	22.3	26.9
Silt	82.7	75.6	71.3
Clay	2.1	2.0	1.8
Chemical Examination			
Organic matter	6.34	4.27	3.30
Total Nitrogen	.39	.07	.04
Potash (K_2O)	.35	.37	.40
Phosphoric acid (P_2O_5)	.07	.07	.08
Lime (CaO)	.73	.42	.31
Magnesia (MgO)	1.01	.23	.42
Iron (Fe_2O_3)	7.51	6.53	4.74
Alumina (Al_2O_3)			
Silica, sol. (SiO_2)			
Free Acidity			
Mycological Examination			
Typical Fusaria	No Panama Disease present		
Other Fusaria			

HONDURAS DIVISION

SERIAL NUMBER *325*

Location: *Villafranca* Farm, Section *; Back of section house.*

Date: *October, 1916.*

Collector: *L. W. W.*

Other distinguishing features:

NATURAL FEATURES

Topography: *Valley.*
Drainage: *Fair.*
Flood conditions: *None.*
Silt deposition: None.
Type of forest growth: *Manaca.*

CULTIVATION HISTORY

When cleared and planted: *1913.*
Number of replantings: *Unknown.* Why?
General condition when in production: *Fair.*
Plowed? *No.* When? Grubbed? *No.* When?
Years in bananas: *Three.* Life of farm: *Fair producer.*
Years in bush or fallow: *Never.*
Other crops grown: *None.*

DISEASE HISTORY

When first noted: *None.*
Age of plants when attacked:
Rapidity of spread:
Treatment given:

OTHER DATA

Owned by native named Villafranca, and situated 29 kilometers west of Tela.

	Surface—6"	6"—18"	18"—30"
Physical Examination			
Color	dark brown	brown	light gray
Compactness	loose	loose	loose
Friability	light	light	light
Retentive power	60	43	29
Mechanical Examination			
Coarse gravel	0	0	0
Fine gravel	0	30.6	14.5
Coarse sand	1.4	8.3	3.1
Fine sand	36.0	25.7	33.0
Silt	60.3	33.7	48.3
Clay	2.3	1.7	1.1
Chemical Examination			
Organic matter	6.33	3.82	2.10
Total Nitrogen	.29	.09	.03
Potash (K_2O)	.51	.34	.63
Phosphoric acid (P_2O_5)	.15	.09	.07
Lime (CaO)	1.28	.38	.54
Magnesia (MgO)	.72	.44	.75
Iron (Fe_2O_3)	3.78	7.50	4.17
Alumina (Al_2O_3)			
Silica, sol. (SiO_2)			
Free Acidity			
Mycological Examination			
Typical Fusaria	No Panama Disease present		
Other Fusaria			

HONDURAS DIVISION

SERIAL NUMBER *326*

Location: *Hill Line* Farm, Section *; At curve in track.*

Date: *October, 1916.*

Other distinguishing features:

Collector: *L. W. W.*

NATURAL FEATURES

Topography: *Valley.*
Drainage: *Fair.*
Flood conditions: *None.*
Silt deposition: *None.*
Type of forest growth: *Manaca.*

CULTIVATION HISTORY

When cleared and planted: *Virgin woodland.*
Number of replantings: Why?
General condition when in production:
Plowed? When? Grubbed? When?
Years in bananas: Life of farm:
Years in bush or fallow:
Other crops grown:

DISEASE HISTORY

When first noted: *None.*
Age of plants when attacked:
Rapidity of spread:
Treatment given:

OTHER DATA

	Surface—6"	6"—18"	18"—30"
Physical Examination			
Color	light brown	gray	gray
Compactness	loose	loose	loose
Friability	light	light	light
Retentive power	40	49	27
Mechanical Examination			
Coarse gravel	0	0	0
Fine gravel	5.1	9.0	26.8
Coarse sand	13.2	16.2	30.6
Fine sand	36.9	31.5	34.4
Silt	43.7	41.7	7.4
Clay	1.1	1.6	.8
Chemical Examination			
Organic matter	3.15	3.30	1.25
Total Nitrogen	.13	.08	.02
Potash (K_2O)	.38	.61	.34
Phosphoric acid (P_2O_5)	.13	.15	.10
Lime (CaO)	.88	1.10	.65
Magnesia (MgO)	.98	.94	.32
Iron (Fe_2O_3)	4.38	4.57	3.22
Alumina (Al_2O_3)			
Silica, sol. (SiO_2)			
Free Acidity			
Mycological Examination			
Typical Fusaria	No Panama Disease present		
Other Fusaria			

HONDURAS DIVISION

SERIAL NUMBER *327*

Location: *Melchers* Farm, Section *; On riverbank.* Date: *October, 1916.*

Other distinguishing features: Collector: *L. W. W.*

NATURAL FEATURES

Topography: *Riverbank.*
Drainage: *Excellent.*
Flood conditions: *About twice a year.*
Silt deposition: *Six inches or more.*
Type of forest growth: *Probably heavy.*

CULTIVATION HISTORY

When cleared and planted: *About 1896.*
Number of replantings: *About five.* Why? *Supplying and floods.*
General condition when in production: *Good.*
Plowed? *No.* When? Grubbed? *No.* When?
Years in bananas: *Twenty.* Life of farm: *Still excellent.*
Years in bush or fallow: *Never.*
Other crops grown: *None.*

DISEASE HISTORY

When first noted: *None.*
Age of plants when attacked:
Rapidity of spread:
Treatment given:

OTHER DATA

	Surface—6"	6"—18"	18"—30"
Physical Examination			
Color	dark brown	brown	brown
Compactness	loose	loose	loose
Friability	light	light	light
Retentive power	65	66	77
Mechanical Examination			
Coarse gravel	0	0	0
Fine gravel	0	0	0
Coarse sand	0	0	0
Fine sand	0.4	0.3	0
Silt	96.3	93.9	93.1
Clay	3.3	5.8	6.9
Chemical Examination			
Organic matter	7.30	6.65	7.28
Total Nitrogen	.13	.12	.09
Potash (K_2O)	.37	.53	.39
Phosphoric acid (P_2O_5)	.15	.13	.11
Lime (CaO)	1.73	1.83	1.17
Magnesia (MgO)	.86	.96	.75
Iron (Fe_2O_3)	5.14	6.16	4.64
Alumina (Al_2O_3)			
Silica, sol. (SiO_2)			
Free Acidity			
Mycological Examination			
Typical Fusaria	No Panama Disease present		
Other Fusaria			

HONDURAS DIVISION

SERIAL NUMBER *328*

Location: *Dora* Farm, Section ; *On riverbank.* Date: *October, 1916.*

Other distinguishing features: Collector: *L. W. W.*

NATURAL FEATURES

Topography: *Riverbank.*
Drainage: *Excellent.*
Flood conditions: *About twice a year.*
Silt deposition: *Six inches a year.*
Type of forest growth: *Probably heavy.*

CULTIVATION HISTORY

When cleared and planted: *About 1896.*
Number of replantings: *About five.* Why? *Supplying and floods.*
General condition when in production: *Good.*
Plowed? *No.* When? Grubbed? *No.* When?
Years in bananas: *About twenty.* Life of farm: *Still good.*
Years in bush or fallow: *Never.*
Other crops grown: *None.*

DISEASE HISTORY

When first noted: *None.*
Age of plants when attacked:
Rapidity of spread:
Treatment given:

OTHER DATA

	Surface—6"	6"—18"	18"—30"
Physical Examination			
Color	light brown	brown	brown
Compactness	loose	loose	loose
Friability	light	light	light
Retentive power	76	71	52
Mechanical Examination			
Coarse gravel	0	0	0
Fine gravel	0	0	0
Coarse sand	0	0	0
Fine sand	0	0	0
Silt	95.4	93.0	93.8
Clay	4.6	7.0	6.2
Chemical Examination			
Organic matter	13.25	6.87	6.73
Total Nitrogen	.01	.10	.10
Potash (K_2O)	.43	.37	.54
Phosphoric acid (P_2O_5)	.13	.12	.26
Lime (CaO)	1.95	2.02	1.32
Magnesia (MgO)	1.20	1.14	1.09
Iron (Fe_2O_3)	6.18	6.12	4.44
Alumina (Al_2O_3)			
Silica, sol. (SiO_2)			
Free Acidity			
Mycological Examination			
Typical Fusaria	No Panama Disease present		
Other Fusaria			

HONDURAS DIVISION

SERIAL NUMBER *329*

Location: *Bogran Estate* Farm, Section ; *By Ulua River.* Date: *October, 1916.*

Other distinguishing features: *Upper end of estate.* Collector: *L. W. W.*

NATURAL FEATURES

Topography: *Riverbank.*
Drainage: *Excellent.*
Flood conditions: *Once a year.*
Silt deposition: *About six inches yearly.*
Type of forest growth: *Heavy.*

CULTIVATION HISTORY

When cleared and planted: *Virgin woodland.*
Number of replantings: Why?
General condition when in production:
Plowed? When? Grubbed? When?
Years in bananas: Life of farm:
Years in bush or fallow:
Other crops grown:

DISEASE HISTORY

When first noted: *None.*
Age of plants when attacked:
Rapidity of spread:
Treatment given:

OTHER DATA

	Surface—6"	6"—18"	18"—30"
Physical Examination			
Color	brown	brown	brown
Compactness	loose	loose	loose
Friability	light	light	light
Retentive power	80	48	54
Mechanical Examination			
Coarse gravel	0	0	0
Fine gravel	0	0	0
Coarse sand	0	0	0
Fine sand	0	0.2	0
Silt	97.5	97.8	97.3
Clay	2.5	2.0	2.7
Chemical Examination			
Organic matter	5.31	3.77	5.06
Total Nitrogen	.11	.05	.06
Potash (K_2O)	.20	.40	.53
Phosphoric acid (P_2O_5)	.14	.11	.10
Lime (CaO)	3.63	2.73	4.10
Magnesia (MgO)	.92	.30	.60
Iron (Fe_2O_3)	4.37	5.01	5.23
Alumina (Al_2O_3)			
Silica, sol. (SiO_2)			
Free Acidity			
Mycological Examination			
Typical Fusaria	No Panama Disease present		
Other Fusaria			

HONDURAS DIVISION

SERIAL NUMBER *330*

Location: *Bogran Estate* Farm, Section *; By Ulua River.*
Other distinguishing features: *Above Progresso.*

Date: *October, 1916.*
Collector: *L. W. W.*

NATURAL FEATURES

Topography: *Riverbank.*
Drainage: *Excellent.*
Flood conditions: *Once a year.*
Silt deposition: *Six inches yearly.*
Type of forest growth: *Heavy wild cane, few big trees.*

CULTIVATION HISTORY

When cleared and planted: *Virgin woodland.*
Number of replantings: Why?
General condition when in production:
Plowed? When? Grubbed? When?
Years in bananas: Life of farm:
Years in bush or fallow:
Other crops grown:

DISEASE HISTORY

When first noted: *None.*
Age of plants when attacked:
Rapidity of spread:
Treatment given:

OTHER DATA

	Surface—6"	6"—18"	18"—30"
Physical Examination			
Color	dark brown	dark brown	dark brown
Compactness	loose	loose	loose
Friability	light	light	light
Retentive power	48	57	49
Mechanical Examination			
Coarse gravel	0	0	0
Fine gravel	0	0	0
Coarse sand	0	0	0
Fine sand	0.5	0.2	0.2
Silt	96.3	97.3	96.7
Clay	3.2	2.5	3.1
Chemical Examination			
Organic matter	6.33	6.68	6.08
Total Nitrogen	.16	.08	.09
Potash (K_2O)	.59	.34	.62
Phosphoric acid (P_2O_5)	.16	.14	.08
Lime (CaO)	3.25	2.25	3.01
Magnesia (MgO)	.28	.45	.87
Iron (Fe_2O_3)	4.65	3.90	4.96
Alumina (Al_2O_3)			
Silica, sol. (SiO_2)			
Free Acidity			
Mycological Examination			
Typical Fusaria	No Panama Disease present		
Other Fusaria			

HONDURAS DIVISION

SERIAL NUMBER *331*

Location: *Bogran Estate* Farm, Section ; *Middle of estate along trail to hills.*

Date: *October, 1916.*
Collector: *L. W. W.*

Other distinguishing features:

NATURAL FEATURES

Topography: *Valley.*
Drainage: *Good.*
Flood conditions: *Wash from hills.*
Silt deposition: *About an inch.*
Type of forest growth: *Very heavy timber.*

CULTIVATION HISTORY

When cleared and planted: *Virgin woodland.*
Number of replantings: Why?
General condition when in production:
Plowed? When? - Grubbed? When?
Years in bananas: Life of farm:
Years in bush or fallow:
Other crops grown:

DISEASE HISTORY

When first noted: *None.*
Age of plants when attacked:
Rapidity of spread:
Treatment given:

OTHER DATA

	Surface—6"	6"—18"	18"—30"
Physical Examination			
Color	light brown	brown	dark brown
Compactness	loose	loose	loose
Friability	light	light	light
Retentive power	49	48	42
Mechanical Examination			
Coarse gravel	0	0	0
Fine gravel	0	0	0
Coarse sand	0	0.4	0
Fine sand	19.9	20.6	4.5
Silt	78.4	76.7	92.3
Clay	1.7	2.3	3.2
Chemical Examination			
Organic matter	4.61	4.63	4.07
Total Nitrogen	.20	.09	.08
Potash (K_2O)	.22	.42	.20
Phosphoric acid (P_2O_5)	.23	.20	.25
Lime (CaO)	2.37	2.00	2.17
Magnesia (MgO)	1.69	1.43	1.98
Iron (Fe_2O_3)	7.36	4.17	8.59
Alumina (Al_2O_3)			
Silica, sol. (SiO_2)			
Free Acidity			
Mycological Examination			
Typical Fusaria	No Panama Disease present		
Other Fusaria			

HONDURAS DIVISION

SERIAL NUMBER *332*

Location: *Bogran Estate* Farm, Section *; Middle of estate.*
Other distinguishing features: *Two and a half hours by mule from Progresso.*

Date: *October, 1916.*
Collector: *L. W. W.*

NATURAL FEATURES

Topography: *Valley.*
Drainage: *Excellent.*
Flood conditions: *Wash from hills.*
Silt deposition: *About an inch a year.*
Type of forest growth: *Very heavy timber.*

CULTIVATION HISTORY

When cleared and planted: *Virgin woodland.*
Number of replantings: Why?
General condition when in production:
Plowed? When? Grubbed? When?
Years in bananas: Life of farm:
Years in bush or fallow:
Other crops grown:

DISEASE HISTORY

When first noted: *None.*
Age of plants when attacked:
Rapidity of spread:
Treatment given:

OTHER DATA

	Surface—6"	6"—18"	18"—30"
Physical Examination			
Color	brown	brown	brown
Compactness	loose	loose	loose
Friability	light	light	rocky
Retentive power	42	29	44
Mechanical Examination			
Coarse gravel	0	0	rocky
Fine gravel	0.5	16.1	0
Coarse sand	2.3	3.3	27.1
Fine sand	17.4	20.1	38.1
Silt	78.2	58.1	33.4
Clay	1.6	2.4	1.4
Chemical Examination			
Organic matter	5.63	5.09	2.66
Total Nitrogen	.25	.08	.04
Potash (K_2O)	.35	.37	.22
Phosphoric acid (P_2O_5)	.14	.11	.14
Lime (CaO)	1.62	1.53	1.84
Magnesia (MgO)	1.37	1.53	1.17
Iron (Fe_2O_3)	7.49	4.08	3.15
Alumina (Al_2O_3)			
Silica, sol. (SiO_2)			
Free Acidity			
Mycological Examination			
Typical Fusaria	No Panama Disease present		
Other Fusaria			

HONDURAS DIVISION

SERIAL NUMBER *333*

Location: *Sulu Pepee* Farm, Section *; Along Ulua River.* Date: *October, 1916.*

Other distinguishing features: Collector: *L. W. W.*

NATURAL FEATURES

Topography: *Valley.*
Drainage: *Excellent.*
Flood conditions: *Twice a year.*
Silt deposition: *Several inches.*
Type of forest growth: *Unknown, probably heavy.*

CULTIVATION HISTORY

When cleared and planted: *About 1901.*
Number of replantings: *About four.* Why? *Supplying and floods.*
General condition when in production: *Good.*
Plowed? *No.* When? Grubbed? *No.* When?
Years in bananas: *About fifteen.* Life of farm: *Still producing well.*
Years in bush or fallow: *Never, so far as known.*
Other crops grown: *None, so far as known.*

DISEASE HISTORY

When first noted: *None.*
Age of plants when attacked:
Rapidity of spread:
Treatment given:

OTHER DATA

	Surface—6"	6"—18"	18"—30"
Physical Examination			
Color	light brown	brown	brown
Compactness	loose	loose	loose
Friability	light	light	light
Retentive power	51	46	61
Mechanical Examination			
Coarse gravel	0	0	0
Fine gravel	0	0	0
Coarse sand	0	0	0
Fine sand	0	0.2	0.4
Silt	96.9	96.9	96.9
Clay	3.1	2.9	2.7
Chemical Examination			
Organic matter	4.52	4.07	3.92
Total Nitrogen	.02	.06	.08
Potash (K_2O)	.43	.55	.69
Phosphoric acid (P_2O_5)	.09	.10	.11
Lime (CaO)	3.55	3.45	3.77
Magnesia (MgO)	.87	.53	.69
Iron (Fe_2O_3)	4.84	2.25	4.88
Alumina (Al_2O_3)			
Silica, sol. (SiO_2)			
Free Acidity			
Mycological Examination			
Typical Fusaria	No Panama Disease present		
Other Fusaria			

HONDURAS DIVISION

SERIAL NUMBER *334*

Location: *Garrisons* Farm, Section *; By house.* Date: *October, 1916.*

Other distinguishing features: Collector: *L. W. W.*

NATURAL FEATURES

Topography: *Valley.*
Drainage: *Excellent.*
Flood conditions: *Twice a year.*
Silt deposition: *Six inches or more.*
Type of forest growth: *Heavy.*

CULTIVATION HISTORY

When cleared and planted: *About 1904.*
Number of replantings: *About three.* Why? *Supplying and floods.*
General condition when in production: *Good.*
Plowed? *No.* When? Grubbed? *No.* When?
Years in bananas: *About twelve.* Life of farm: *Still good.*
Years in bush or fallow: *Never.*
Other crops grown: *None.*

DISEASE HISTORY

When first noted: *None.*
Age of plants when attacked:
Rapidity of spread:
Treatment given:

OTHER DATA

	Surface—6"	6"—18"	18"—30"
Physical Examination			
Color	brown	brown	brown
Compactness	loose	loose	loose
Friability	light	light	light
Retentive power	70	54	60
Mechanical Examination			
Coarse gravel	0	0	0
Fine gravel	0	0	0
Coarse sand	0	0	0
Fine sand	0	0	0
Silt	95.9	96.2	95.2
Clay	4.1	3.8	4.8
Chemical Examination			
Organic matter	8.48	5.52	6.49
Total Nitrogen	.09	.07	.09
Potash (K_2O)	.37	1.23	1.55
Phosphoric acid (P_2O_5)	.12	.12	.15
Lime (CaO)	3.59	3.14	4.75
Magnesia (MgO)	.99	.80	1.00
Iron (Fe_2O_3)	5.05	4.92	5.94
Alumina (Al_2O_3)			
Silica, sol. (SiO_2)			
Free Acidity			
Mycological Examination			
Typical Fusaria	No Panama Disease present		
Other Fusaria			

HONDURAS DIVISION

SERIAL NUMBER *335*

Location: *Pica Maya* Farm, Section ; *By Ulua River.* Date: *October, 1916.*

Other distinguishing features: Collector: *L. W. W.*

NATURAL FEATURES

Topography: *Valley.*
Drainage: *Excellent.*
Flood conditions: *Twice a year.*
Silt deposition: *Six inches.*
Type of forest growth: *Probably heavy.*

CULTIVATION HISTORY

When cleared and planted: *About 1901.*
Number of replantings: *About four.* Why? *Supplying and floods.*
General condition when in production: *Good.*
Plowed? *No.* When? Grubbed? *No.* When?
Years in bananas: *About fifteen.* Life of farm: *Still producing well.*
Years in bush or fallow: *Never.*
Other crops grown: *None.*

DISEASE HISTORY

When first noted: *None.*
Age of plants when attacked:
Rapidity of spread:
Treatment given:

OTHER DATA

	Surface—6"	6"—18"	18"—30"
Physical Examination			
Color	brown	brown	brown
Compactness	loose	loose	loose
Friability	light	light	light
Retentive power	62	77	74
Mechanical Examination			
Coarse gravel	0	0	0
Fine gravel	0	0	0
Coarse sand	0	0	0
Fine sand	0	0	0
Silt	97.4	94.3	94.7
Clay	2.6	5.7	5.3
Chemical Examination			
Organic matter	6.82	6.28	7.52
Total Nitrogen	.18	.08	.09
Potash (K_2O)	.42	.79	.38
Phosphoric acid (P_2O_5)	.65	.12	.11
Lime (CaO)	3.64	2.96	3.88
Magnesia (MgO)	.80	.94	1.05
Iron (Fe_2O_3)	5.24	5.82	5.82
Alumina (Al_2O_3)			
Silica, sol. (SiO_2)			
Free Acidity			
Mycological Examination			
Typical Fusaria	No Panama Disease present		
Other Fusaria			

Average Analyses — Honduras

Sample	Fine Gravel	Coarse Sand	Fine Sand	Silt	Clay	K_2O	CaO	MgO	Fe_2O_3	P_2O_5	Vol. Mat.	Tot. N	RP
Indiana	0	0	0	96.2	3.8	.36	.57	1.05	7.06	.11	9.29	.18	72
Indiana	0	0	0	95.4	4.6	.29	.49	1.18	6.95	.10	7.80	.14	74
Dakota	0	0.7	21.1	77.2	1.0	.29	.68	.70	5.58	.12	3.90	.04	40
Sisama	0	0	5.4	90.9	3.7	.37	.77	.92	6.15	.08	8.71	.08	66
Alabama	0	0	0.3	97.5	2.2	.58	.66	.82	6.89	.27	5.97	.03	53
California	0	0	0	96.8	3.2	.22	.46	.67	6.73	.11	8.03	.13	72
Ceibita	0	0	0.1	96.1	3.8	.26	1.31	.92	6.53	.16	8.48	.09	65
Uluasito	0	0	19.2	79.1	1.7	.15	.69	.83	6.23	.19	6.31	.14	45
Uluasito	0	0	0.1	95.8	4.1	.26	.62	1.00	8.00	.20	6.07	.08	63
El Eden	0	0	2.2	94.9	3.9	.16	.28	.27	5.30	.17	12.12	.05	59
Estero Claro	0	0	0.1	97.2	2.7	.29	1.06	.79	6.29	.23	7.79	.09	62
Zuniga	3.7	4.8	5.2	81.4	1.9	.56	.69	.75	7.19	.16	4.36	.11	40
Jilamo	0	0	0.4	96.6	3.0	.80	1.10	1.13	7.14	.23	5.31	.14	61
Arizona	1.6	5.1	18.2	73.0	2.1	.37	.44	.08	3.29	.15	6.77	.12	53
Las Palmas	0	0.1	12.8	84.2	2.9	.83	1.06	1.22	5.20	.28	6.69	.08	63
San Alejos	0.2	5.0	20.7	71.6	2.5	.45	.81	1.37	4.78	.13	3.61	.08	36
San Alejos	3.0	1.1	8.0	84.4	3.5	.46	1.36	1.04	6.23	.27	7.81	.10	65
San Alejos	2.8	1.2	6.2	87.4	2.4	.54	.91	.95	6.06	.23	7.06	.16	67
San Alejos	1.2	6.2	33.6	57.4	1.6	.94	1.02	.99	5.26	.18	3.67	.10	39
Esperanza	0	0	2.9	94.0	3.1	.39	.56	.76	5.05	.17	8.18	.19	64
Esperanza	0.1	2.1	29.4	65.4	3.0	.40	.89	.83	4.31	.15	6.58	.19	57
Agua Blanca	0	0.3	9.8	87.2	2.7	.62	1.00	.92	7.56	.10	6.88	.08	73
Uluita	0	0	0.7	95.6	3.7	.88	.94	.80	6.96	.13	7.79	.15	71
Fortuna	0	0	22.7	75.4	1.9	.38	.44	.46	6.01	.07	4.30	.12	48
Villafranca	18.0	4.8	30.7	44.9	1.6	.49	.62	.62	5.42	.09	3.63	.11	41

Hill Line	15.3	21.3	33.7	28.5	1.2	.45	.88	.70	3.99	.13	2.45	.07	38
Melchers	0	0	0.2	94.1	5.7	.44	1.55	.86	5.35	.13	7.03	.11	70
Dora	0	0	0	93.8	6.2	.45	1.73	1.13	5.46	.18	8.09	.08	64
Bogran Estate	0	0	0.1	97.5	2.4	.41	3.46	.54	4.97	.11	4.59	.07	57
Bogran Estate	0	0	0.3	96.8	2.9	.50	2.75	.58	4.47	.12	6.37	.10	52
Bogran Estate	0	0.2	14.0	83.3	2.5	.29	2.14	1.70	6.57	.23	4.40	.11	46
Bogran Estate	7.4	12.6	26.8	51.4	1.8	.31	1.67	1.35	4.39	.13	4.23	.10	38
Sulu Pepee	0	0	0.2	96.9	2.9	.50	3.60	.66	3.42	.10	4.10	.06	53
Garrisons	0	0	0	95.7	4.3	1.19	3.87	.92	5.35	.13	6.46	.08	60
Pica Maya	0	0	0	95.1	4.9	.55	3.46	.97	5.70	.22	7.08	.10	73
Whole Division	1.8	2.3	10.4	82.5	3.0	.51	1.57	.92	5.06	.15	6.56	.09	64

AVERAGE OF RESULTS BY DISTRICTS

Colorado	.04	.07	5.9	90.1	2.9	.39	.73	.82	6.30	.17	7.17	.12	59
San Alejos	1.8	3.4	17.1	75.2	2.5	.60	1.02	1.09	5.58	.20	5.54	.11	52
Port Arturo	4.8	4.1	18.5	70.1	2.5	.52	.76	.73	5.61	.12	5.69	.13	56
Ulua River	0	0	0.1	95.1	4.8	.64	2.84	.91	5.06	.15	6.53	.09	64
Bogran Estate	1.9	3.2	10.3	82.2	2.4	.38	2.50	1.04	5.10	.15	4.89	.09	48

Ratio of Lime to Magnesia

1–1 to 5–1 regarded as normal

301. Indiana
.8–1
.5–1
.5–1

302. Indiana
.6–1
.4–1
2.0–1

303. Dakota
1.0–1
.9–1
.1–1

304. Sisama
1.4–1
.5–1
1.0–1

305. Alabama
.4–1
1.2–1
.8–1

306. California
.8–1
.5–1
.8–1

307. Ceibita
2.0–1
1.1–1
2.0–1

308. Uluasito
.9–1
.8–1
rock

309. Uluasito
.7–1
.8–1
.5–1

310. El Eden
.6–1
2.0–1
1.0–1

311. Estero Claro
.9–1
2.0–1
1.2–1

312. Zuniga
.8–1
1.0–1
1.0–1

313. Jilamo
.3–1
1.0–1
1.3–1

314. Arizona
7.0–1
3.0–1
5.0–1

315. Las Palmas
1.1–1
1.1–1
.6–1

316. San Alejos
.5–1
.6–1
.6–1

317. San Alejos
2.0–1
1.4–1
.9–1

318. San Alejos
2.0–1
.9–1
.6–1

319. San Alejos
.9–1
.8–1
1.6–1

320. Esperanza
.9–1
.8–1
.5–1

321. Esperanza
2.5–1
.7–1
.8–1

322. Agua Blanca
.7–1
1.1–1
1.2–1

323. Uluita
1.1–1
.9–1
2.3–1

324. Fortuna
.7–1
2.0–1
.8–1

325. Villafranca
1.7–1
.8–1
.8–1

326. Hill Line
.9–1
1.2–1
2.0–1

327. Melchers
2.0–1
2.0–1
1.3–1

328. Dora
1.5–1
1.9–1
1.2–1

329. Bogran Estate
4.0–1
9.0–1
7.0–1

330. Bogran Estate
12.0–1
5.0–1
4.0–1

331. Bogran Estate
1.8-1
1.3–1
1.1–1

332. Bogran Estate
1.1–1
1.0–1
1.3–1

333. Sulu Pepee
4.0–1
6.0–1
5.0–1

334. Garrisons
3.0–1
4.0–1
4.7–1

335. Pica Maya
4.0–1
2.5–1
3.4–1

Ratio of Organic Matter to Nitrogen

30–1 to 40–1 regarded as normal

301. Indiana
33–1
66–1
70–1

302. Indiana
19–1
87–1
76–1

303 Dakota
563–1
60–1
91–1

304. Sisama
19–1
87–1
75–1

305 Alabama
689–1
85–1

306. California
58–1
79–1
59–1

307. Ceibita
1261–1
70–1
71–1

308. Uluasito
36–1
45–1

309. Uluasito
70–1
75–1
62–1

310. El Eden
1682–1
106–1

311. Estero Claro
1305–1
54–1
60–1

312. Zuniga
32–1
38–1
48–1

313. Jilamo
17–1
52–1
77–1

314. Arizona
29–1
59–1
80–1

315. Las Palmas
600–1
39–1
67–1

316. San Alejos
23–1
68–1
81–1

317. San Alejos
1379–1
46–1
56–1

318. San Alejos
57–1
43–1
48–1

319. San Alejos
20–1
66–1
175–1

320. Esperanza
28–1
45–1
65–1

321. Esperanza
26–1
50–1
45–1

322. Agua Blanca
27–1
66–1
70–1

323. Uluita
42–1
54–1
51–1

324. Fortuna	328. Dora	332. Bogran Estate
15–1	1325–1	23–1
61–1	68–1	63–1
82–1	67–1	66–1
325. Villafranca	329. Bogran Estate	333. Sulu Pepee
21–1	49–1	221–1
35–1	74–1	65–1
70–1	83–1	48–1
326. Hill Line	330. Bogran Estate	334. Garrisons
24–1	39–1	81–1
40–1	82–1	79–1
24–1	58–1	71–1
327. Melchers	331. Bogran Estate	335. Pica Maya
56–1	43–1	38–1
51–1	43–1	77–1
72–1	36–1	82–1

The general conclusion from this table is that the total nitrogen is proportionally much lower than is to be expected from the organic matter found, although the organic matter itself is subnormal. This may mean a failure to fix the nitrogen introduced with organic matter as a result of faulty bacterial activity, or it may in part be due to excessive leaching.

Examination of Individual Farms.

Indiana. A relatively young farm in which three mild diseases of the banana have appeared. The soil has a good analysis except for deficiency in lime and phosphoric acid, but it has an excess of magnesia.

Indiana. Soil is refractory, and the farm is deficient in plant nutrients, especially lime and phosphoric acid, and has an excess of magnesia.

Dakota. Low in lime and magnesia and very low in total nitrogen.

Sisama. A refractory soil deficient in all plant nutrients except potash.

Alabama. A refractory soil deficient in plant nutrients and especially deficient in nitrogen.

California. A refractory soil with a generally low analysis.

Ceibita. A fair analysis, but low in total nitrogen.

Uluasito. Low in potash and lime especially.

Uluasito. Woodland. Low in lime, organic matter and nitrogen.

El Eden. A refractory, thin soil very low in lime and nitrogen.

Estero Claro. A soil of good depth, but lacking in organic matter and nitrogen.

Zuniga. A soil of fair value, rich in potash, but low in lime and very low in organic matter.

Jilamo. A soil of good analysis except for low organic matter.

Arizona. A refractory soil with poor history and generally low analysis except for potash, but good depth.

Las Palmas. A good soil lacking in sufficient organic matter and nitrogen.

San Alejos tract. Some variation of depth, but all the soils show high potash and low organic matter as seems to be characteristic of forest soils. The general analysis indicates that some good farms might be obtained here.

Esperanza. A farm in which the chief deficiency is lime; organic matter is rather low.

Agua Blanca. A soil deficient in organic matter, nitrogen and phosphoric acid.

Uluita. Low in lime and organic matter.

Fortuna. A thin soil very low in organic matter and phosphoric acid, and deficient in lime.

Villafranca. A thin soil low in all plant nutrients except potash.

Hill Line. A forest soil containing considerable fine gravel and coarse sand, thin and generally low except in potash.

Melchers. A fair soil lacking in organic matter and phosphoric acid.

Dora. Its chief fault is an insufficiency of nitrogen.

Bogran Estate. Somewhat variable in different parts, but all areas sampled show very low organic matter, a little nitrogen and phosphoric acid.

Sulu Pepee. A soil rich in potash and lime, but low in other nutrients.

Garrisons. A soil very rich in potash and lime, low in other nutrients.

Pica Maya. Rich in potash and lime, low in organic matter and nitrogen.

Expressing the general character of the soil by the terms "high," "medium" and "low," the results tabulated below have been obtained. Attention is directed to the fact that most of the soils which on physical examination have proved to be hard and refractory have had a poor cultivation history.

This is probably explainable because of the difficulties of the plant in securing good rootage and consequently deficient nutriment, although the percentage of nutritive materials may be entirely satisfactory. Another fact brought out in the comparison of physical and chemical data is the evident lack of humus as indicated by the light coloring.

Tabular View of Soil Conditions

Explanation of Abbreviations

Potash— h = greater than .30%
l = less than .15%

Lime— h = greater than 2%
l = less than 1%

Organic Matter—h = greater than 15%
l = less than 9%

Nitrogen— h = greater than .30%
l = less than .15%

Phosphoric Acid—h = greater than .30%
l = less than .15%

h = high m = medium r = rapid * = hard, refractory soil
l = low v = very s = slow

Farm	*History*	*Depth*	*Potash*	*Lime*	*Organic Matter*	*Nitrogen*	*Phosphoric Acid*	*Disease Spread*
Indiana	scanty	fair	h	l	m	m	l	s
*Indiana	poor	good	m–h	l	l	ml	l	
Dakota	good	good	m–h	l	vl	vl	l	s
*Sisama	poor	fair	h	l	lm	vl	vl	
*Alabama	poor	fair	h	l	l	vl	m	
*California	poor	good	m	l	lm	ml	l	
Ceibita	good	good	m	m	lm	l	m–l	
Uluasito	good	thin	m–l	l	l	ml	m	
Uluasito	–	good	m	l	l	l	m	
*El Eden	good	thin	m	vl	mh	vl	m	
Estero Claro	fair	good	m–h	m	l	l	m	
Zuniga	–	fair	vh	l	vl	l	m	
Jilamo	good	good	vh	m	l	ml	m	
*Arizona	poor	good	h	l	l	ml	l	s
Las Palmas	good	good	vh	m	l	l	m–h	

San Alejos	–	fair	h		vl	l	m–h	
San Alejos	–	good	h	m	l	m	m	
San Alejos	–	fair	h	l	l	m	m	
San Alejos	–	very thin	vh	m	vl	l	m	
Esperanza	good	good	h	l	ml	m	m	s
Esperanza	good to bad	thin	h	l	l	m	m–l	s
Agua Blanca	good	good	h	m	l	l	l	s
Uluita	good	good	h	l	l	m	l	
Fortuna	good	thin	h	l	vl	ml	vl	
Villafranca	fair	thin	h	l	vl	l	l	
Hill Line	–	thin	h	l	vl	vl	l	
Melchers	good	good	h	m	l	l	l	
Dora	good	good	h	m–h	ml	l	m	
Bogran Estate	–	fair	h	h	vl	l	l	
Bogran Estate	–	good	h	h	l	l	l	
Bogran Estate	–	good	m	l	vl	l	m	
Bogran Estate	–	thin	m	m	vl	l	l	
Sulu Pepee	good	good	h	vh	vl	l	l	
Garrisons	good	good	vh	vh	l	l	l	
Pica Maya	good	good	h	vh	l	l	m	

JAMAICA DIVISION

The Jamaica Division differs somewhat from all other divisions in its geological character. The island is supposed to be of marine origin, which accounts for the large amount of lime in certain portions of it. It is precipitous, much divided into small valleys and consequently does not show the alluvial character of the soils of the coastal plains. The island varies widely in rainfall and general character, portions of the south side of the island requiring irrigation, while only a few miles away across the dividing mountain range rainfall is abundant. This island has been under cultivation for a great many years and the lands now used for banana farms have previously been used for general cultivation and for the growth of sugar cane. The production records or agricultural histories of these farms are seriously interfered with because of the large number of hurricanes or tropical storms which have visited the island and which in many instances have brought utter ruin to the crops. On this account the history is in a number of instances greatly deficient. Undoubtedly these are the most alkaline soils of any which have been examined in this investigation. The Division is characterized as a whole by high potash, medium lime content and a fair amount of phosphoric acid. In a majority of the samples examined organic matter and nitrogen are found to be low, much lower in fact than in the nearest of the Central American Divisions. Iron is very high throughout this Division and undoubtedly the phosphoric acid is rendered only slightly available on this account.

JAMAICA DIVISION

SERIAL NUMBER *401*

Location: *Bushy Park* Farm, Section . Date: *November, 1916.*

Other distinguishing features: *Lower end of farm.* Collector: *L. W. W.*

NATURAL FEATURES

Topography: *Bottom land.*
Drainage: *Good.*
Flood conditions: *No.*
Silt deposition: *No.*
Type of forest growth: *Cleared a great many years ago.*

CULTIVATION HISTORY

When cleared and planted: *No records, purchased by U. F. Co. in 1911.*
Number of replantings: *Two.* Why? *Hurricanes.*
General condition when in production: *Good.*
Plowed: *Yes.* When? *Yearly.* Grubbed? *Yes.* When? *Yearly.*
Years in bananas: *Five.* Life of farm: *Very good condition.*
Years in bush or fallow: *Many years in Guinea grass before 1911.*
Other crops grown:

DISEASE HISTORY

When first noted: *None.*
Age of plants when attacked:
Rapidity of spread:
Treatment given:

OTHER DATA

Only one crop of bananas was reaped before the hurricane of 1915. It was blown down again in 1916.

	Surface—6"	6"—18"	18"—30"
Physical Examination			
Color	dark brown	dark brown	dark brown
Compactness	loose	loose	loose
Friability	light	light	light
Retentive power	58	58	55
Mechanical Examination			
Coarse gravel	0	0	0
Fine gravel	0	0	0
Coarse sand	0	0	0
Fine sand	0	0	0
Silt	96.9	96.7	96.2
Clay	3.1	3.3	3.8
Chemical Examination			
Organic matter	9.42	5.32	4.17
Total Nitrogen	.22	.15	.01
Potash (K_2O)	.47	.27	.28
Phosphoric acid (P_2O_5)	.13	.24	.17
Lime (CaO)	.98	.97	1.28
Magnesia (MgO)	.73	.71	.35
Iron (Fe_2O_3)	7.31	6.90	6.01
Alumina (Al_2O_3)			
Silica, sol. (SiO_2)			
Free Acidity			
Mycological Examination			
Typical Fusaria	No Panama Disease present		
Other Fusaria			

JAMAICA DIVISION

SERIAL NUMBER *402*

Location: *Pumpkin Ground* Farm, Section . Date: *November, 1916.*

Other distinguishing features: Collector: *L. W. W.*

NATURAL FEATURES

Topography: *Bottom land.*
Drainage: *Good.*
Flood conditions: *None.*
Silt deposition: *None.*
Type of forest growth: *Unknown.*

CULTIVATION HISTORY

When cleared and planted: *In bananas about 1901.*
Number of replantings: *About five.* Why? *General practice.*
General condition when in production: *Good.*
Plowed? *Yes.* When? *Yearly.* Grubbed? *Yes.* When? *Yearly.*
Years in bananas: *About fifteen.* Life of farm: *Becoming exhausted.*
Years in bush or fallow: *Part of the time; no exact data.*
Other crops grown: *Unknown.*

DISEASE HISTORY

When first noted: *None.*
Age of plants when attacked:
Rapidity of spread:
Treatment given:

OTHER DATA

This land requires rest and manuring, and will give only two crops before replanting.

	Surface—6"	6"—18"	18"—30"
Physical Examination			
Color	light brown	light brown	light brown
Compactness	loose	loose	loose
Friability	light	light	light
Retentive power	69	57	58
Mechanical Examination			
Coarse gravel	0	0	0
Fine gravel	0	0	0
Coarse sand	0	0	0
Fine sand	0	0	0
Silt	96.2	96.5	96.8
Clay	3.8	3.5	3.2
Chemical Examination			
Organic matter	10.02	5.66	4.38
Total Nitrogen	.21	.15	.08
Potash (K_2O)	.40	.39	.22
Phosphoric acid (P_2O_5)	.15	.35	.20
Lime (CaO)	1.80	2.66	2.26
Magnesia (MgO)	.63	.86	.49
Iron (Fe_2O_3)	6.17	6.29	6.41
Alumina (Al_2O_3)			
Silica, sol. (SiO_2)			
Free Acidity			
Mycological Examination			
Typical Fusaria	No Panama Disease present		
Other Fusaria			

JAMAICA DIVISION

SERIAL NUMBER *403*

Location: *Cooksons* Farm, Section .

Date: *November, 1916.*

Other distinguishing features:

Collector: *L. W. W.*

NATURAL FEATURES

Topography: *Bottom land.*
Drainage: *Good.*
Flood conditions: *None.*
Silt deposition: *None.*
Type of forest growth: *Unknown.*

CULTIVATION HISTORY

When cleared and planted: *In bananas about 1900.*
Number of replantings: *About five.* Why? *General practice.*
General condition when in production: *Good.*
Plowed? *Yes.* When? *Yearly.* Grubbed? *Yes.* When? *Yearly.*
Years in bananas: *About sixteen.* Life of farm: *Becoming exhausted.*
Years in bush or fallow: *Part of the time, no exact data.*
Other crops grown: *Has been in Guinea grass and shade trees.*

DISEASE HISTORY

When first noted: *None.*
Age of plants when attacked:
Rapidity of spread:
Treatment given:

OTHER DATA

Land requires rest and manuring. Produces about three good crops, after which replanting is necessary.

	Surface—6"	6"—18"	18"—30"
Physical Examination			
Color	dark brown	dark brown	dark brown
Compactness	loose	loose	loose
Friability	light	light	light
Retentive power	46	49	43
Mechanical Examination			
Coarse gravel	0	0	0
Fine gravel	0	0	0
Coarse sand	0	0	0
Fine sand	0	0	0
Silt	97.8	97.7	97.7
Clay	2.2	2.3	2.3
Chemical Examination			
Organic matter	4.47	4.83	4.33
Total Nitrogen	.19	.14	.05
Potash (K_2O)	.42	.35	.23
Phosphoric acid (P_2O_5)	.33	.23	.14
Lime (CaO)	1.21	.33	1.49
Magnesia (MgO)	.90	.77	.93
Iron (Fe_2O_3)	6.23	6.86	8.35
Alumina (Al_2O_3)			
Silica, sol. (SiO_2)			
Free Acidity			
Mycological Examination			
Typical Fusaria	No Panama Disease present		
Other Fusaria			

JAMAICA DIVISION

SERIAL NUMBER *404*

Location: *Bushy Park* Farm, Section ; *Middle of farm.* Date: *November, 1916.*

Other distinguishing features: *Near house.* Collector: *L. W. W.*

NATURAL FEATURES

Topography: *Bottom land.*
Drainage: *Fair.*
Flood conditions: *None.*
Silt deposition: *None.*
Type of forest growth: *No data.*

CULTIVATION HISTORY

When cleared and planted: *In bananas 1909.*
Number of replantings: *One.* Why? *Hurricanes and severe droughts.*
General condition when in production: *Not very good, because of above.*
Plowed? *Yes.* When? *Yearly.* Grubbed? *Yes.* When? *Yearly.*
Years in bananas: *Seven.* Life of farm: *Soil not considered suited for bananas.*
Years in bush or fallow: *No records.*
Other crops grown: *No records.*

DISEASE HISTORY

When first noted: *None.*
Age of plants when attacked:
Rapidity of spread:
Treatment given:

OTHER DATA

Mr. Scudamore classes this as a poor banana soil, with stiff clay subsoil.

	Surface—6"	6"—18"	18"—30"
PHYSICAL EXAMINATION			
Color	dark brown	dark brown	dark brown
Compactness	hard	hard	hard
Friability	heavy	heavy	heavy
Retentive power	52	66	58
MECHANICAL EXAMINATION			
Coarse gravel	0	0	0
Fine gravel	0	0	0
Coarse sand	0	0	0
Fine sand	0	0	0
Silt	95.8	95.9	96.2
Clay	4.2	4.1	3.8
CHEMICAL EXAMINATION			
Organic matter	6.95	7.02	5.82
Total Nitrogen	.15	.09	0
Potash (K_2O)	.24	.25	.13
Phosphoric acid (P_2O_5)	.23	.20	.25
Lime (CaO)	.70	.23	1.07
Magnesia (MgO)	.97	1.08	.32
Iron (Fe_2O_3)	7.24	8.34	8.42
Alumina (Al_2O_3)			
Silica, sol. (SiO_2)			
Free Acidity			
MYCOLOGICAL EXAMINATION			
Typical Fusaria	No Panama Disease present		
Other Fusaria			

JAMAICA DIVISION

SERIAL NUMBER *405*

Location: *Bushy Park* Farm, Section ; *Gravel piece.* Date: *November, 1916.*

Other distinguishing features: Collector: *L. W. W.*

NATURAL FEATURES

Topography: *Bottom land.*
Drainage: *Good.*
Flood conditions: *None.*
Silt deposition: *None.*
Type of forest growth: *No records.*

CULTIVATION HISTORY

When cleared and planted: *Bananas in 1909.*
Number of replantings: *1915.* Why? *Hurricane.*
General condition when in production: *Fair.*
Plowed? *Yes.* When? *Yearly.* Grubbed? *Yes.* When? *Yearly.*
Years in bananas: *Seven.* Life of farm: *Not considered good banana land.*
Years in bush or fallow: *No data.*
Other crops grown: *No data.*

DISEASE HISTORY

When first noted:
Age of plants when attacked:
Rapidity of spread:
Treatment given:

OTHER DATA

Weather conditions have affected this farm, due to hurricanes and severe droughts.

	Surface—6"	6"—18"	18"—30"
Physical Examination			
Color	dark brown	dark brown	dark brown
Compactness	loose	loose	loose
Friability	heavy	heavy	heavy
Retentive power	61	56	49
Mechanical Examination			
Coarse gravel	0	0	0
Fine gravel	0	0	0
Coarse sand	0	0	0
Fine sand	0	0	0
Silt	95.1	96.5	94.9
Clay	4.9	3.5	5.1
Chemical Examination			
Organic matter	4.47	1.85	6.40
Total Nitrogen	.12	.09	0
Potash (K_2O)	.23	.28	.25
Phosphoric acid (P_2O_5)	.04	.10	.17
Lime (CaO)	1.00	1.04	1.00
Magnesia (MgO)	.46	1.07	.41
Iron (Fe_2O_3)	7.55	6.92	7.05
Alumina (Al_2O_3)			
Silica, sol. (SiO_2)			
Free Acidity			
Mycological Examination			
Typical Fusaria	No Panama Disease present		
Other Fusaria			

JAMAICA DIVISION

SERIAL NUMBER *406*

Location: *Salt Ponds* Farm, Section . Date: *November, 1916.*

Other distinguishing features: Collector: *L. W. W.*

NATURAL FEATURES

Topography: *Bottom land.*
Drainage: *Fair.*
Flood conditions: *None.*
Silt deposition: *None.*
Type of forest growth: *No records.*

CULTIVATION HISTORY

When cleared and planted: *1896.*
Number of replantings: *About ten.* Why? *General practice.*
General condition when in production: *Fair.*
Plowed? *Yes.* When? *Yearly.* Grubbed? *Yes.* When? *Yearly.*
Years in bananas: *Twenty.* Life of farm: *Abandoned for bananas.*
Years in bush or fallow: *Pasture before 1896.*
Other crops grown: *Coconuts being planted.*

DISEASE HISTORY

When first noted: *None.*
Age of plants when attacked:
Rapidity of spread:
Treatment given:

OTHER DATA

	Surface—6"	6"—18"	18"—30"
Physical Examination			
Color	dark brown	dark brown	light brown
Compactness	hard	hard	hard
Friability	heavy	heavy	heavy
Retentive power	58	53	35
Mechanical Examination			
Coarse gravel	0	0	0
Fine gravel	0	0	0
Coarse sand	0	0	26.0
Fine sand	0	0	37.1
Silt	93.6	96.1	35.0
Clay	6.4	3.9	1.9
Chemical Examination			
Organic matter	5.95	6.48	4.06
Total Nitrogen	.14	.10	.04
Potash (K_2O)	.35	.50	.19
Phosphoric acid (P_2O_5)	.18	.27	.15
Lime (CaO)	.84	1.36	2.67
Magnesia (MgO)	.28	.58	.83
Iron (Fe_2O_3)	6.78	7.06	8.22
Alumina (Al_2O_3)			
Silica, sol. (SiO_2)			
Free Acidity			
Mycological Examination			
Typical Fusaria	No Panama Disease present		
Other Fusaria			

JAMAICA DIVISION

SERIAL NUMBER *407*

Location: *Williamsfield* Farm, Section ; *Hillside.* Date: *November, 1916.*

Other distinguishing features: Collector: *L. W. W.*

NATURAL FEATURES

Topography: *Hillside.*
Drainage: *Poor.*
Flood conditions: *None.*
Silt deposition: *None.*
Type of forest growth: *No records.*

CULTIVATION HISTORY

When cleared and planted: *No records.*
Number of replantings: *No records.* Why?
General condition when in production: *No records.*
Plowed? When? Grubbed? When?
Years in bananas: *No records.* Life of farm:
Years in bush or fallow: *No records.*
Other crops grown: *No records.*

DISEASE HISTORY

When first noted: *None.*
Age of plants when attacked:
Rapidity of spread:
Treatment given:

OTHER DATA

This is not considered by Mr. Scudamore as good banana land.

	Surface—6"	6"—18"	18"—30"
Physical Examination			
Color	red brown	red brown	red brown
Compactness	hard	hard	hard
Friability	refractory	refractory	refractory
Retentive power	90	75	87
Mechanical Examination			
Coarse gravel	0	0	0
Fine gravel	0	0	0
Coarse sand	0	0	0
Fine sand	0	0	0
Silt	93.8	93.5	93.4
Clay	6.2	6.5	6.6
Chemical Examination			
Organic matter	21.50	15.55	10.73
Total Nitrogen	.56	.28	.25
Potash (K_2O)	.37	.35	.41
Phosphoric acid (P_2O_5)	.94	.95	.97
Lime (CaO)	1.60	.87	.84
Magnesia (MgO)	.53	.94	.84
Iron (Fe_2O_3)	14.95	14.88	12.82
Alumina (Al_2O_3)			
Silica, sol. (SiO_2)			
Free Acidity			
Mycological Examination			
Typical Fusaria	No Panama Disease present		
Other Fusaria			

JAMAICA DIVISION

SERIAL NUMBER *408*

Location: *Williamsfield* Farm, Section *; Hillside, west.* Date: *November, 1916.*

Other distinguishing features: Collector: *L. W. W.*

NATURAL FEATURES

Topography: *Hillside.*
Drainage: *Good.*
Flood conditions: *None.*
Silt deposition: *None.*
Type of forest growth: *No records.*

CULTIVATION HISTORY

When cleared and planted: *Bananas 1911.*
Number of replantings: *Two.* Why? *Hurricanes.*
General condition when in production: *Excellent for three years.*
Plowed? *Yes.* When? *Yearly.* Grubbed? *Yes.* When? *Yearly.*
Years in bananas: *Five.* Life of farm: *Destroyed by hurricane, 1916.*
Years in bush or fallow: *No data.*
Other crops grown: *Coconuts planted.*

DISEASE HISTORY

When first noted: *None.*
Age of plants when attacked:
Rapidity of spread:
Treatment given:

OTHER DATA

	Surface—6"	6"—18"	18"—30"
Physical Examination			
Color	black	black	black
Compactness	loose	loose	loose
Friability	heavy	heavy	heavy
Retentive power	92	93	80
Mechanical Examination			
Coarse gravel	0	0	0
Fine gravel	0	0	0
Coarse sand	0	0	0
Fine sand	0	0	0
Silt	91.8	91.6	91.4
Clay	8.2	8.4	8.6
Chemical Examination			
Organic matter	13.31	8.70	9.91
Total Nitrogen	.30	.39	.28
Potash (K_2O)	.41	.26	.40
Phosphoric acid (P_2O_5)	.35	.16	.18
Lime (CaO)	3.67	6.17	8.92
Magnesia (MgO)	1.37	1.42	1.17
Iron (Fe_2O_3)	5.79	7.00	5.71
Alumina (Al_2O_3)			
Silica, sol. (SiO_2)			
Free Acidity			
Mycological Examination			
Typical Fusaria	No Panama Disease present		
Other Fusaria			

JAMAICA DIVISION

SERIAL NUMBER *409*

Location: *Windsor* Farm, Section *; Swamp piece.* Date: *November, 1916.*

Other distinguishing features: Collector: *L. W. W.*

NATURAL FEATURES

Topography: *Valley.*
Drainage: *Fair.*
Flood conditions: *None.*
Silt deposition: *None.*
Type of forest growth: *Heavy woodland.*

CULTIVATION HISTORY

When cleared and planted: *1887–8.*
Number of replantings: *About fifteen.* Why? *General practice.*
General condition when in production: *Good.*
Plowed? *Yes.* When? *Yearly.* Grubbed? *Yes.* When? *Yearly.*
Years in bananas: *Thirty.* Life of farm: *Still good.*
Years in bush or fallow: *Part of the time, no exact data.*
Other crops grown: *None.*

DISEASE HISTORY

When first noted: *None.*
Age of plants when attacked:
Rapidity of spread:
Treatment given:

OTHER DATA

	Surface—6"	6"—18"	18"—30"
Physical Examination			
Color	light brown	light brown	light brown
Compactness	loose	loose	loose
Friability	light	light	light
Retentive power	61	63	59
Mechanical Examination			
Coarse gravel	0	0	0
Fine gravel	0	0	0
Coarse sand	0	0	0
Fine sand	0	0	0
Silt	98.3	98.0	98.1
Clay	1.7	2.0	1.9
Chemical Examination			
Organic matter	6.08	5.67	6.63
Total Nitrogen	.14	.14	.06
Potash (K_2O)	.36	.38	.38
Phosphoric acid (P_2O_5)	.10	.13	.07
Lime (CaO)	1.51	.23	1.03
Magnesia (MgO)	1.13	1.35	.47
Iron (Fe_2O_3)	7.47	7.62	8.17
Alumina (Al_2O_3)			
Silica, sol. (SiO_2)			
Free Acidity			
Mycological Examination			
Typical Fusaria	No Panama Disease present		
Other Fusaria			

JAMAICA DIVISION

SERIAL NUMBER *410*

Location: *Windsor* Farm, Section *; Swamp piece.* Date: *November, 1916.*

Other distinguishing features: *Hilltop.* Collector: *L. W. W.*

NATURAL FEATURES

Topography: *Hilltop.*
Drainage: *Fair.*
Flood conditions: *None.*
Silt deposition: *None.*
Type of forest growth: *Heavy.*

CULTIVATION HISTORY

When cleared and planted: *1889.*
Number of replantings: *About twelve.* Why? *General practice.*
General condition when in production: *Good.*
Plowed? *Yes.* When? *Yearly.* Grubbed? *Yes.* When? *Yearly.*
Years in bananas: *About twenty-eight.* Life of farm: *About exhausted.*
Years in bush or fallow: *Part of the time.*
Other crops grown: *No data.*

DISEASE HISTORY

When first noted: *None.*
Age of plants when attacked:
Rapidity of spread:
Treatment given:

OTHER DATA

Soil apparently exhausted and requires manure. Will produce only two crops before replanting.

	Surface—6"	6"—18"	18"—30"
Physical Examination			
Color	yellow brown	yellow brown	yellow brown
Compactness	loose	loose	loose
Friability	light	light	light
Retentive power	71	70	63
Mechanical Examination			
Coarse gravel	0	0	0
Fine gravel	0	0	0
Coarse sand	0	0	0
Fine sand	0	0	0
Silt	96.8	97.2	97.3
Clay	3.2	2.8	2.7
Chemical Examination			
Organic matter	10.85	6.91	11.01
Total Nitrogen	.19	.15	.11
Potash (K_2O)	.41	.45	.25
Phosphoric acid (P_2O_5)	.16	.10	.10
Lime (CaO)	.79	.58	.14
Magnesia (MgO)	1.07	.90	.71
Iron (Fe_2O_3)	16.48	10.20	10.85
Alumina (Al_2O_3)			
Silica, sol. (SiO_2)			
Free Acidity			
Mycological Examination			
Typical Fusaria	No Panama Disease present		
Other Fusaria			

JAMAICA DIVISION

SERIAL NUMBER *411*

Location: *Seamans Valley* Farm, Section ; *Jack Spring.* Date: *November, 1916.*

Other distinguishing features: Collector: *L. W. W.*

NATURAL FEATURES

Topography: *Valley.*
Drainage: *Fair.*
Flood conditions: *None.*
Silt deposition: *None.*
Type of forest growth: *Probably heavy.*

CULTIVATION HISTORY

When cleared and planted: *About 1890.*
Number of replantings: *About ten.* Why? *General practice.*
General condition when in production: *Good.*
Plowed? *Yes.* When? *Yearly.* Grubbed? *Yes.* When? *Yearly.*
Years in bananas: *Twenty-five.* Life of farm: *Still good.*
Years in bush or fallow: *No record.*
Other crops grown: *No record.*

DISEASE HISTORY

When first noted: *None.*
Age of plants when attacked:
Rapidity of spread:
Treatment given:

OTHER DATA

	Surface—6"	6"—18"	18"—30"
Physical Examination			
Color	dark brown	dark brown	light brown
Compactness	loose	loose	loose
Friability	light	light	light
Retentive power	77	74	70
Mechanical Examination			
Coarse gravel	0	0	0
Fine gravel	0	0	0
Coarse sand	0	0	0
Fine sand	0	0	0
Silt	97.9	97.7	97.9
Clay	2.1	2.3	2.1
Chemical Examination			
Organic matter	10.44	6.41	7.16
Total Nitrogen	.17	.20	.10
Potash (K_2O)	.52	.35	.37
Phosphoric acid (P_2O_5)	.24	.15	.16
Lime (CaO)	2.18	1.89	1.29
Magnesia (MgO)	1.71	1.86	1.44
Iron (Fe_2O_3)	6.28	7.79	6.68
Alumina (Al_2O_3)			
Silica, sol. (SiO_2)			
Free Acidity			
Mycological Examination			
Typical Fusaria	No Panama Disease present		
Other Fusaria			

JAMAICA DIVISION

SERIAL NUMBER *412*

Location: *Kildare* Farm, Section . Date: *November, 1916.*

Other distinguishing features: Collector: *L. W. W.*

NATURAL FEATURES

Topography: *Hillside.*
Drainage: *Fair.*
Flood conditions: *None.*
Silt deposition: *None.*
Type of forest growth: *Probably heavy.*

CULTIVATION HISTORY

When cleared and planted: *1913.*
Number of replantings: *Two.* Why? *Hurricanes.*
General condition when in production: *No crops reaped.*
Plowed? *Yes.* When? *Yearly.* Grubbed? *Yes.* When? *Yearly.*
Years in bananas: *Three.* Life of farm: *Bananas only to establish coconuts.*
Years in bush or fallow: *Never.*
Other crops grown: *Coconuts planted.*

DISEASE HISTORY

When first noted: *None.*
Age of plants when attacked:
Rapidity of spread:
Treatment given:

OTHER DATA

Coconuts are doing well on this land.

	Surface—6"	6"—18"	18"—30"
PHYSICAL EXAMINATION			
Color	light brown	light brown	light brown
Compactness	loose	loose	loose
Friability	light	light	light
Retentive power	56	51	52
MECHANICAL EXAMINATION			
Coarse gravel	0	0	0
Fine gravel	0	0	0
Coarse sand	0	0	0
Fine sand	0	0	0
Silt	98.1	98.4	98.2
Clay	1.9	1.6	1.8
CHEMICAL EXAMINATION			
Organic matter	7.28	5.17	6.63
Total Nitrogen	.10	.06	.06
Potash (K_2O)	.38	.32	.29
Phosphoric acid (P_2O_5)	.16	.13	.15
Lime (CaO)	.48	.33	.39
Magnesia (MgO)	.51	.28	.41
Iron (Fe_2O_3)	4.62	6.40	6.75
Alumina (Al_2O_3)			
Silica, sol. (SiO_2)			
Free Acidity			
MYCOLOGICAL EXAMINATION			
Typical Fusaria	No Panama Disease present		
Other Fusaria			

JAMAICA DIVISION

SERIAL NUMBER *413*

Location: *Kildare* Farm, Section . Date: *November, 1916.*

Other distinguishing features: Collector: *L. W. W.*

NATURAL FEATURES

Topography: *Hilltop.*
Drainage: *Fair.*
Flood conditions: *None.*
Silt deposition: *None.*
Type of forest growth: *Probably heavy.*

CULTIVATION HISTORY

When cleared and planted: *1913.*
Number of replantings: *Two.* Why? *Hurricanes.*
General condition when in production: *Crops never reaped.*
Plowed? *Yes.* When? *Yearly.* Grubbed? *Yes.* When? *Yearly.*
Years in bananas: *Three.* Life of farm: *Bananas to establish coconuts.*
Years in bush or fallow: *Never.*
Other crops grown: *None.*

DISEASE HISTORY

When first noted: *None.*
Age of plants when attacked:
Rapidity of spread:
Treatment given:

OTHER DATA

	Surface—6"	6"—18"	18"—30"
Physical Examination			
Color	light brown	light brown	red brown
Compactness	loose	loose	loose
Friability	light	light	light
Retentive power	72	70	66
Mechanical Examination			
Coarse gravel	0	0	0
Fine gravel	0	0	0
Coarse sand	0	0	0
Fine sand	0	0	0
Silt	95.5	95.9	95.8
Clay	4.5	4.1	4.2
Chemical Examination			
Organic matter	10.00	8.20	8.93
Total Nitrogen	.18	.15	.08
Potash (K_2O)	.30	.21	.29
Phosphoric acid (P_2O_5)	.15	.19	.10
Lime (CaO)	.39	.37	.38
Magnesia (MgO)	.43	.18	.28
Iron (Fe_2O_3)	5.83	6.40	5.12
Alumina (Al_2O_3)			
Silica, sol. (SiO_2)			
Free Acidity			
Mycological Examination			
Typical Fusaria	Panama Disease present in farm		
Other Fusaria			

JAMAICA DIVISION

SERIAL NUMBER *414*

Location: *Paradise* Farm, Section . Date: *November, 1916.*

Other distinguishing features: *Near river.* Collector: *L. W. W.*

NATURAL FEATURES

Topography: *Valley.*
Drainage: *Fair.*
Flood conditions: *None.*
Silt deposition: *None.*
Type of forest growth: *Heavy woodland.*

CULTIVATION HISTORY

When cleared and planted: *1913.*
Number of replantings: *Two.* Why? *Hurricanes.*
General condition when in production: *No crops reaped.*
Plowed? *Yes.* When? *Yearly.* Grubbed? *Yes.* When? *Yearly.*
Years in bananas: *Three.* Life of farm: *Bananas grow well.*
Years in bush or fallow: *Never.*
Other crops grown: *None.*

DISEASE HISTORY

When first noted: *Several cases of Panama Disease in 1916.*
Age of plants when attacked: *Six months.*
Rapidity of spread: *Slow.*
Treatment given: *Digging out, burning and bleaching.*

OTHER DATA

	Surface—6"	6"—18"	18"—30"
Physical Examination			
Color	red brown	light brown	light brown
Compactness	loose	loose	loose
Friability	light	light	light
Retentive power	71	74	72
Mechanical Examination			
Coarse gravel	0	0	0
Fine gravel	0	0	0
Coarse sand	0	0	0
Fine sand	0	0	0
Silt	94.3	94.7	93.1
Clay	5.7	5.3	6.9
Chemical Examination			
Organic matter	14.68	6.85	8.82
Total Nitrogen	.24	.12	.11
Potash (K_2O)	.39	.40	.42
Phosphoric acid (P_2O_5)	.19	.21	.27
Lime (CaO)	1.67	6.82	1.78
Magnesia (MgO)	.60	1.06	.70
Iron (Fe_2O_3)	7.24	6.78	6.68
Alumina (Al_2O_3)			
Silica, sol. (SiO_2)			
Free Acidity			
Mycological Examination			
Typical Fusaria	Panama Disease present in farm		
Other Fusaria			

JAMAICA DIVISION

SERIAL NUMBER *415*

Location: *Paradise* Farm, Section ; *On hill.* Date: *November, 1916.*

Other distinguishing features: Collector: *L. W. W.*

NATURAL FEATURES

Topography: *Hilltop.*
Drainage: *Fair.*
Flood conditions: *None.*
Silt deposition: *None.*
Type of forest growth: *Heavy.*

CULTIVATION HISTORY

When cleared and planted: *Some years ago, no exact data.*
Number of replantings: *No data.* Why?
General condition when in production: *Good.*
Plowed? *Yes.* When? *Yearly.* Grubbed? *Yes.* When? *Yearly.*
Years in bananas: *Several.* Life of farm: *Now exhausted.*
Years in bush or fallow: *No data.*
Other crops grown: *No data.*

DISEASE HISTORY

When first noted: *Several cases of Panama Disease in farm in 1916.*
Age of plants when attacked: *Six months.*
Rapidity of spread: *Slow.*
Treatment given: *Digging out, burning and bleaching.*

OTHER DATA

	Surface—6"	6"—18"	18"—30"
PHYSICAL EXAMINATION			
Color	light brown	light brown	yellow
Compactness	hard	hard	hard
Friability	refractory	refractory	refractory
Retentive power	100	80	97
MECHANICAL EXAMINATION			
Coarse gravel	0	0	0
Fine gravel	0	0	0
Coarse sand	0	0	0
Fine sand	0	0	0
Silt	93.4	93.8	93.3
Clay	6.6	6.2	6.7
CHEMICAL EXAMINATION			
Organic matter	10.22	9.38	6.92
Total Nitrogen	.27	.27	.12
Potash (K_2O)	.55	.38	.46
Phosphoric acid (P_2O_5)	.19	.22	.16
Lime (CaO)	2.59	1.52	1.07
Magnesia (MgO)	.62	.21	.40
Iron (Fe_2O_3)	4.56	6.38	6.69
Alumina (Al_2O_3)			
Silica, sol. (SiO_2)			
Free Acidity			
MYCOLOGICAL EXAMINATION			
Typical Fusaria	Panama Disease present in farm		
Other Fusaria			

JAMAICA DIVISION

SERIAL NUMBER *416*

Location: *Hermitage* Farm, Section . Date: *November, 1916.*

Other distinguishing features: Collector: *L. W. W.*

NATURAL FEATURES

Topography: *Bottom land.*
Drainage: *Poor.*
Flood conditions: *None.*
Silt deposition: *None.*
Type of forest growth: *None.*

CULTIVATION HISTORY

When cleared and planted: *1903, after hurricane destroyed coconuts.*
Number of replantings: *None.* Why? *Bananas abandoned.*
General condition when in production: *Fair.*
Plowed? *Yes.* When? *Yearly.* Grubbed? *Yes.* When? *Yearly.*
Years in bananas: *About five.* Life of farm: *Coconuts only.*
Years in bush or fallow: *Never.*
Other crops grown: *Coconuts now the only crop.*

DISEASE HISTORY

When first noted: *None.*
Age of plants when attacked:
Rapidity of spread:
Treatment given:

OTHER DATA

	Surface—6"	6"—18"	18"—30"
Physical Examination			
Color	dark brown	dark brown	light brown
Compactness	hard	hard	hard
Friability	refractory	refractory	refractory
Retentive power	78	77	64
Mechanical Examination			
Coarse gravel	0	0	0
Fine gravel	0	0	0
Coarse sand	0	0	0
Fine sand	0	0	0
Silt	93.9	92.7	93.8
Clay	6.1	7.3	6.2
Chemical Examination			
Organic matter	13.11	13.02	10.02
Total Nitrogen	.30	.25	.01
Potash (K_2O)	.40	.46	.44
Phosphoric acid (P_2O_5)	.15	.19	.18
Lime (CaO)	.81	.86	.91
Magnesia (MgO)	.34	.40	1.38
Iron (Fe_2O_3)	6.31	8.08	9.68
Alumina (Al_2O_3)			
Silica, sol. (SiO_2)			
Free Acidity			
Mycological Examination			
Typical Fusaria	No Panama Disease present		
Other Fusaria			

JAMAICA DIVISION

SERIAL NUMBER *417*

Location: *Hermitage* Farm, Section .

Date: *November, 1916.*

Other distinguishing features:

Collector: *L. W. W.*

NATURAL FEATURES

Topography: *Bottom land.*
Drainage: *Poor.*
Flood conditions: *None.*
Silt deposition: *None.*
Type of forest growth: *None.*

CULTIVATION HISTORY

When cleared and planted: *1903, after hurricane destroyed coconuts.*
Number of replantings: *None.* Why? *Bananas abandoned.*
General condition when in production: *Fair.*
Plowed? *Yes.* When? *Yearly.* Grubbed? *Yes.* When? *Yearly.*
Years in bananas: *About five.* Life of farm: *Coconuts only.*
Years in bush or fallow: *Never.*
Other crops grown: *Coconuts now the only crop.*

DISEASE HISTORY

When first noted: *None.*
Age of plants when attacked:
Rapidity of spread:
Treatment given:

OTHER DATA

	Surface—6"	6"—18"	18"—30"
PHYSICAL EXAMINATION			
Color	dark brown	dark brown	dark brown
Compactness	hard	hard	hard
Friability	refractory	refractory	refractory
Retentive power	94	95	93
MECHANICAL EXAMINATION			
Coarse gravel	0	0	0
Fine gravel	0	0	0
Coarse sand	0	0	0
Fine sand	0	0	0
Silt	92.5	91.7	92.0
Clay	7.5	8.3	8.0
CHEMICAL EXAMINATION			
Organic matter	14.57	7.10	9.38
Total Nitrogen	.39	.23	.19
Potash (K_2O)	.49	.49	.46
Phosphoric acid (P_2O_5)	.23	.23	.19
Lime (CaO)	.15	1.32	1.71
Magnesia (MgO)	1.06	.47	80
Iron (Fe_2O_3)	6.61	7.68	6.77
Alumina (Al_2O_3)			
Silica, sol. (SiO_2)			
Free Acidity			
MYCOLOGICAL EXAMINATION			
Typical Fusaria	No Panama Disease present		
Other Fusaria			

JAMAICA DIVISION

SERIAL NUMBER *418*

Location: *Red Hazel* Farm, Section . Date: *November, 1916.*

Other distinguishing features: Collector: *L. W. W.*

NATURAL FEATURES

Topography: *Bottom land.*
Drainage: *Fair.*
Flood conditions: *None.*
Silt deposition: *None.*
Type of forest growth: *None.*

CULTIVATION HISTORY

When cleared and planted: *Very old, no exact data.*
Number of replantings: *No data.* Why?
General condition when in production: *Very good.*
Plowed? *Yes.* When? *Yearly.* Grubbed? *Yes.* When? *Yearly.*
Years in bananas: *Great many.* Life of farm: *Somewhat exhausted.*
Years in bush or fallow: *No data.*
Other crops grown: *No data.*

DISEASE HISTORY

When first noted: *None.*
Age of plants when attacked:
Rapidity of spread:
Treatment given:

OTHER DATA

	Surface—6"	6"—18"	18"—30"
Physical Examination			
Color	red brown	red brown	red brown
Compactness	loose	loose	loose
Friability	light	light	light
Retentive power	82	70	72
Mechanical Examination			
Coarse gravel	0	0	0
Fine gravel	0	0	0
Coarse sand	0	0	0
Fine sand	0	0	0
Silt	95.7	95.9	94.4
Clay	4.3	4.1	5.6
Chemical Examination			
Organic matter	9.68	7.12	8.72
Total Nitrogen	.15	.14	.12
Potash (K_2O)	.42	.12	.27
Phosphoric acid (P_2O_5)	.11	.06	.10
Lime (CaO)	2.14	.71	.98
Magnesia (MgO)	1.05	.21	1.10
Iron (Fe_2O_3)	11.60	9.52	10.00
Alumina (Al_2O_3)			
Silica, sol. (SiO_2)			
Free Acidity			
Mycological Examination			
Typical Fusaria	No Panama Disease present		
Other Fusaria			

JAMAICA DIVISION

SERIAL NUMBER *419*

Location: *Fellowship* Farm, Section ; *Hillside.*

Date: *November, 1916.*

Other distinguishing features:

Collector: *L. W. W.*

NATURAL FEATURES

Topography: *Hillside.*
Drainage: *Fair.*
Flood conditions: *None.*
Silt deposition: *None.*
Type of forest growth: *No data.*

CULTIVATION HISTORY

When cleared and planted: *1916 in bananas.*
Number of replantings: *None.* Why?
General condition when in production: *Plants look promising.*
Plowed? *No.* When? Grubbed? *No* When?
Years in bananas: *Six months.* Life of farm:
Years in bush or fallow: *In pasture for years.*
Other crops grown: *None.*

DISEASE HISTORY

When first noted: *None.*
Age of plants when attacked:
Rapidity of spread:
Treatment given:

OTHER DATA

	Surface—6"	6"—18"	18"—30"
Physical Examination			
Color	yellow	yellow	yellow
Compactness	hard	hard	hard
Friability	refractory	refractory	refractory
Retentive power	74	79	82
Mechanical Examination			
Coarse gravel	0	0	0
Fine gravel	0	0	0
Coarse sand	0	0	0
Fine sand	0	0	0
Silt	92.6	91.9	92.5
Clay	7.4	8.1	7.5
Chemical Examination			
Organic matter	15.60	10.72	6.47
Total Nitrogen	.16	.13	.10
Potash (K_2O)	.53	.40	.40
Phosphoric acid (P_2O_5)	.15	.17	.17
Lime (CaO)	.12	.21	.10
Magnesia (MgO)	1.31	1.49	1.38
Iron (Fe_2O_3)	8.37	8.81	9.67
Alumina (Al_2O_3)			
Silica, sol. (SiO_2)			
Free Acidity			
Mycological Examination			
Typical Fusaria	No Panama Disease present		
Other Fusaria			

JAMAICA DIVISION

SERIAL NUMBER *420*

Location: *Fellowship* Farm, Section ; *By river.* Date: *November, 1916.*

Other distinguishing features: Collector: *L. W. W.*

NATURAL FEATURES

Topography: *Bottom land.*
Drainage: *Good.*
Flood conditions: *Seldom.*
Silt deposition: *Slight.*
Type of forest growth: *No data.*

CULTIVATION HISTORY

When cleared and planted: *Over twenty years ago.*
Number of replantings: *About five.* Why? *General practice.*
General condition when in production: *Good.*
Plowed? *Yes.* When? *Yearly.* Grubbed? *Yes.* When? *Yearly.*
Years in bananas: *Over twenty.* Life of farm: *Is becoming exhausted.*
Years in bush or fallow: *Part of time, no exact data.*
Other crops grown: *No data.*

DISEASE HISTORY

When first noted: *None.*
Age of plants when attacked:
Rapidity of spread:
Treatment given:

OTHER DATA

	Surface—6"	6"—18"	18"—30"
Physical Examination			
Color	dark brown	light brown	light brown
Compactness	loose	loose	loose
Friability	light	light	light
Retentive power	68	66	78
Mechanical Examination			
Coarse gravel	0	0	0
Fine gravel	0	0	0
Coarse sand	0	0	0
Fine sand	0	0	0
Silt	96.7	95.8	96.4
Clay	3.3	4.2	3.6
Chemical Examination			
Organic matter	10.62	8.02	6.49
Total Nitrogen	.18	.30	.12
Potash (K_2O)	.35	.19	.45
Phosphoric acid (P_2O_5)	.23	.12	.09
Lime (CaO)	1.79	.29	1.73
Magnesia (MgO)	.30	.78	.62
Iron (Fe_2O_3)	7.72	8.40	8.73
Alumina (Al_2O_3)			
Silica, sol. (SiO_2)			
Free Acidity			
Mycological Examination			
Typical Fusaria	No Panama Disease present		
Other Fusaria			

JAMAICA DIVISION

SERIAL NUMBER *421*

Location: *Stanton* Farm, Section . Date: *November, 1916.*

Other distinguishing features: Collector: *L. W. W.*

NATURAL FEATURES

Topography: *Bottom land.*
Drainage: *Fair.*
Flood conditions: *None.*
Silt deposition: *None.*
Type of forest growth: *No data.*

CULTIVATION HISTORY

When cleared and planted: *Over twenty-five years ago.*
Number of replantings: *About eight.* Why? *General practice.*
General condition when in production: *Good.*
Plowed? *Yes.* When? *Yearly.* Grubbed? *Yes.* When? *Yearly.*
Years in bananas: *Over twenty-five.* Life of farm: *Becoming exhausted.*
Years in bush or fallow: *No data.*
Other crops grown: *No data.*

DISEASE HISTORY

When first noted: *None.*
Age of plants when attacked:
Rapidity of spread:
Treatment given:

OTHER DATA

	Surface—6"	6"—18"	18"—30"
Physical Examination			
Color	light brown	light brown	light brown
Compactness	loose	loose	loose
Friability	light	light	light
Retentive power	77	57	70
Mechanical Examination			
Coarse gravel	0	0	0
Fine gravel	0	0	0
Coarse sand	0	0	0
Fine sand	0	0	0
Silt	94.1	95.1	93.8
Clay	5.9	4.9	6.2
Chemical Examination			
Organic matter	7.37	6.88	6.46
Total Nitrogen	.15	.08	.62
Potash (K_2O)	.43	.37	.39
Phosphoric acid (P_2O_5)	.16	.18	.16
Lime (CaO)	.77	.87	.87
Magnesia (MgO)	.78	.85	.38
Iron (Fe_2O_3)	7.07	6.43	6.17
Alumina (Al_2O_3)			
Silica, sol. (SiO_2)			
Free Acidity			
Mycological Examination			
Typical Fusaria	No Panama Disease present		
Other Fusaria			

JAMAICA DIVISION

SERIAL NUMBER *422*

Location: *Golden Grove* Farm, Section . Date: *November, 1916.*

Other distinguishing features: *Cotton Tree piece.* Collector: *L. W. W.*

NATURAL FEATURES

Topography: *Bottom land.*
Drainage: *Fair.*
Flood conditions: *About once a year.*
Silt deposition: *None.*
Type of forest growth: *No data.*

CULTIVATION HISTORY

When cleared and planted: *In cane over 100 years, bananas 25 years ago.*
Number of replantings: *About ten.* Why? *General practice.*
General condition when in production: *Good.*
Plowed? *Yes.* When? *Yearly.* Grubbed? *Yes.* When? *Yearly.*
Years in bananas: *About twenty.* Life of farm: *Bananas abandoned four years.*
Years in bush or fallow: *Pasture four years.*
Other crops grown: *Cane before bananas.*

DISEASE HISTORY

When first noted: *None.*
Age of plants when attacked:
Rapidity of spread:
Treatment given:

OTHER DATA

Land has been intensely cultivated. Required replanting about every two years.

	Surface—6"	6"—18"	18"—30"
PHYSICAL EXAMINATION			
Color	dark brown	dark brown	dark brown
Compactness	loose	loose	loose
Friability	light	light	light
Retentive power	73	79	58
MECHANICAL EXAMINATION			
Coarse gravel	0	0	0
Fine gravel	0	0	0
Coarse sand	0	0	0
Fine sand	0	0	0
Silt	94.8	93.8	94.1
Clay	5.2	6.2	5.9
CHEMICAL EXAMINATION			
Organic matter	9.96	7.68	5.97
Total Nitrogen	.18	.19	.08
Potash (K_2O)	.50	.41	.20
Phosphoric acid (P_2O_5)	.15	.14	.18
Lime (CaO)	1.86	2.05	2.20
Magnesia (MgO)	1.56	1.04	1.02
Iron (Fe_2O_3)	8.27	6.35	7.10
Alumina (Al_2O_3)			
Silica, sol. (SiO_2)			
Free Acidity			
MYCOLOGICAL EXAMINATION			
Typical Fusaria	Panama Disease present		
Other Fusaria			

JAMAICA DIVISION

SERIAL NUMBER *423*

Location: *Golden Grove* Farm, Section .

Date: *November, 1916.*

Other distinguishing features: *Venture piece.*

Collector: *L. W. W.*

NATURAL FEATURES

Topography: *Bottom land.*
Drainage: *Fair.*
Flood conditions: *About once a year.*
Silt deposition: *None.*
Type of forest growth: *No data.*

CULTIVATION HISTORY

When cleared and planted: *In cane over 100 years, bananas 25 years ago.*
Number of replantings: *About ten.* Why? *General practice.*
General condition when in production: *Good.*
Plowed? *Yes.* When? *Yearly.* Grubbed? *Yes.* When? *Yearly.*
Years in bananas: *About twenty.* Life of farm: *Bananas abandoned five years.*
Years in bush or fallow: *Pasture for four years.*
Other crops grown: *Cane for over a hundred years.*

DISEASE HISTORY

When first noted: *None.*
Age of plants when attacked:
Rapidity of spread:
Treatment given:

OTHER DATA

	Surface—6"	6"—18"	18"—30"
Physical Examination			
Color	light brown	light brown	light brown
Compactness	loose	loose	loose
Friability	light	light	light
Retentive power	71	66	66
Mechanical Examination			
Coarse gravel	0	0	0
Fine gravel	0	0	0
Coarse sand	0	0	0
Fine sand	0	0	0
Silt	94.2	94.1	93.9
Clay	5.8	5.9	6.1
Chemical Examination			
Organic matter	9.92	6.64	7.54
Total Nitrogen	.21	.17	.13
Potash (K_2O)	.35	.50	.45
Phosphoric acid (P_2O_5)	.15	.15	.11
Lime (CaO)	2.26	2.11	2.59
Magnesia (MgO)	.85	.65	2.05
Iron (Fe_2O_3)	7.75	5.57	8.42
Alumina (Al_2O_3)			
Silica, sol. (SiO_2)			
Free Acidity			
Mycological Examination			
Typical Fusaria	No Panama Disease present		
Other Fusaria			

JAMAICA DIVISION

SERIAL NUMBER *424*

Location: *Golden Grove* Farm, Section . Date: *November, 1916.*

Other distinguishing features: *Holland Dam piece.* Collector: *L. W. W.*

NATURAL FEATURES

Topography: *Bottom land.*
Drainage: *Fair.*
Flood conditions: *About once a year.*
Silt deposition: *About two inches.*
Type of forest growth: *No data.*

CULTIVATION HISTORY

When cleared and planted: *For many years.*
Number of replantings: *Many.* Why?
General condition when in production: *Good.*
Plowed? *Yes.* When? *Yearly.* Grubbed? *Yes.* When? *Yearly.*
Years in bananas: *Many.* Life of farm: *Still producing.*
Years in bush or fallow: *Never.*
Other crops grown: *No data.*

DISEASE HISTORY

When first noted: *None.*
Age of plants when attacked:
Rapidity of spread:
Treatment given:

OTHER DATA

This land produces excellent fruit and has been in cultivation for a great many years.

	Surface—6″	6″—18″	18″—30″
Physical Examination			
Color	light brown	light brown	light brown
Compactness	loose	loose	loose
Friability	light	light	light
Retentive power	63	68	50
Mechanical Examination			
Coarse gravel	0	0	0
Fine gravel	0	0	0
Coarse sand	0	0	0
Fine sand	0	0	0
Silt	94.9	95.2	95.4
Clay	5.1	4.8	4.6
Chemical Examination			
Organic matter	6.24	6.38	8.40
Total Nitrogen	.13	.15	.09
Potash (K_2O)	.55	.36	.28
Phosphoric acid (P_2O_5)	.14	.14	.19
Lime (CaO)	4.27	1.93	2.48
Magnesia (MgO)	2.36	.33	.72
Iron (Fe_2O_3)	9.11	6.55	6.82
Alumina (Al_2O_3)			
Silica, sol. (SiO_2)			
Free Acidity			
Mycological Examination			
Typical Fusaria	No Panama Disease present		
Other Fusaria			

JAMAICA DIVISION

SERIAL NUMBER *425*

Location: *Wheelerfield* Farm, Section .

Date: *November, 1916.*

Other distinguishing features: *Corn piece.*

Collector: *L. W. W.*

NATURAL FEATURES

Topography: *Valley.*
Drainage: *Fair.*
Flood conditions: *None.*
Silt deposition: *None.*
Type of forest growth: *No data.*

CULTIVATION HISTORY

When cleared and planted: *In bananas about twenty years.*
Number of replantings: *About ten.* Why? *General practice.*
General condition when in production: *Fair.*
Plowed? *Yes.* When? *Yearly.* Grubbed? *Yes.* When? *Yearly.*
Years in bananas: *About twenty.* Life of farm: *Becoming exhausted.*
Years in bush or fallow: *Part of the time.*
Other crops grown: *Sugar cane a hundred years before bananas.*

DISEASE HISTORY

When first noted: *None.*
Age of plants when attacked:
Rapidity of spread:
Treatment given:

OTHER DATA

This land requires rest and manure.

	Surface—6"	6"—18"	18"—30"
Physical Examination			
Color	dark brown	dark brown	dark brown
Compactness	loose	loose	loose
Friability	light	light	light
Retentive power	72	63	65
Mechanical Examination			
Coarse gravel	0	0	0
Fine gravel	0	0	0
Coarse sand	0	0	0
Fine sand	0	0	0
Silt	96.0	96.3	95.6
Clay	4.0	3.7	4.4
Chemical Examination			
Organic matter	7.72	10.55	5.13
Total Nitrogen	.21	.18	.12
Potash (K_2O)	.20	.15	.41
Phosphoric acid (P_2O_5)	.26	.18	.20
Lime (CaO)	21.08	23.22	16.30
Magnesia (MgO)	1.96	1.29	1.67
Iron (Fe_2O_3)	6.37	5.08	6.36
Alumina (Al_2O_3)			
Silica, sol. (SiO_2)			
Free Acidity			
Mycological Examination			
Typical Fusaria	No Panama Disease present		
Other Fusaria			

JAMAICA DIVISION

SERIAL NUMBER *426*

Location: *Wheelerfield* Farm, Section . Date: *November, 1916.*

Other distinguishing features: *Grandiman piece.* Collector: *L. W. W.*

NATURAL FEATURES

Topography: *Valley.*
Drainage: *Fair.*
Flood conditions: *None.*
Silt deposition: *None.*
Type of forest growth: *No data.*

CULTIVATION HISTORY

When cleared and planted: *In bananas twenty years, cane over a hundred.*
Number of replantings: *About ten.* Why? *General practice.*
General condition when in production: *Good.*
Plowed? *Yes.* When? *Yearly.* Grubbed? *Yes.* When? *Yearly.*
Years in bananas: *About twenty.* Life of farm: *Still producing.*
Years in bush or fallow: *Part of the time.*
Other crops grown: *No data.*

DISEASE HISTORY

When first noted: *None.*
Age of plants when attacked:
Rapidity of spread:
Treatment given:

OTHER DATA

	Surface—6"	6"—18"	18"—30"
Physical Examination			
Color	light brown	light brown	light brown
Compactness	loose	loose	loose
Friability	light	light	light
Retentive power	69	73	59
Mechanical Examination			
Coarse gravel	0	0	0
Fine gravel	0	0	0
Coarse sand	0	0	0
Fine sand	0	0	0
Silt	94.2	94.3	94.4
Clay	5.8	5.7	5.6
Chemical Examination			
Organic matter	8.99	7.27	6.60
Total Nitrogen	.21	.13	.10
Potash (K_2O)	.43	.21	.43
Phosphoric acid (P_2O_5)	.06	.12	.16
Lime (CaO)	4.98	1.61	2.73
Magnesia (MgO)	1.25	.83	.92
Iron (Fe_2O_3)	7.93	8.90	8.35
Alumina (Al_2O_3)			
Silica, sol. (SiO_2)			
Free Acidity			
Mycological Examination			
Typical Fusaria	No Panama Disease present		
Other Fusaria			

JAMAICA DIVISION

SERIAL NUMBER *427*

Location: *Phillipfield* Farm, Section .
Date: *November, 1916.*
Other distinguishing features: *Fourth piece.*
Collector: *L. W. W.*

NATURAL FEATURES

Topography: *Hillside.*
Drainage: *Fair.*
Flood conditions: *None.*
Silt deposition: *None.*
Type of forest growth: *No data.*

CULTIVATION HISTORY

When cleared and planted: *About 1896.*
Number of replantings: *About ten.* Why? *General practice.*
General condition when in production: *Good.*
Plowed? *Yes.* When? *Yearly.* Grubbed? *Yes.* When? *Yearly.*
Years in bananas: *About twenty.* Life of farm: *Nearly exhausted.*
Years in bush or fallow: *No data.*
Other crops grown: *No data.*

DISEASE HISTORY

When first noted: *None.*
Age of plants when attacked:
Rapidity of spread:
Treatment given:

OTHER DATA

	Surface—6"	6"—18"	18"—30"
Physical Examination			
Color	light brown	light brown	light brown
Compactness	loose	loose	loose
Friability	light	light	light
Retentive power	73	79	76
Mechanical Examination			
Coarse gravel	0	0	0
Fine gravel	0	0	0
Coarse sand	0	0	0
Fine sand	0	0	0
Silt	92.5	91.1	92.1
Clay	7.5	8.9	7.9
Chemical Examination			
Organic matter	9.78	10.15	10.77
Total Nitrogen	.14	.32	.04
Potash (K_2O)	.45	.47	.30
Phosphoric acid (P_2O_5)	.35	.08	.12
Lime (CaO)	5.97	3.38	2.52
Magnesia (MgO)	1.40	1.21	1.04
Iron (Fe_2O_3)	5.74	6.97	6.75
Alumina (Al_2O_3)			
Silica, sol. (SiO_2)			
Free Acidity			
Mycological Examination			
Typical Fusaria	No Panama Disease present		
Other Fusaria			

JAMAICA DIVISION

SERIAL NUMBER *428*

Location: *Pleasant Hill* Farm, Section . . Date: *November, 1916.*

Other distinguishing features: *Old sugar works.* Collector: *L. W. W.*

NATURAL FEATURES

Topography: *Hillside.*
Drainage: *Fair.*
Flood conditions: *None.*
Silt deposition: *None.*
Type of forest growth: *No data.*

CULTIVATION HISTORY

When cleared and planted: *1884.*
Number of replantings: *No data.* Why?
General condition when in production:
Plowed? When? Grubbed? When?
Years in bananas: *No data.* Life of farm: *Abandoned for bananas.*
Years in bush or fallow: *No data.*
Other crops grown: *Old sugar estate.*

DISEASE HISTORY

When first noted: *None.*
Age of plants when attacked:
Rapidity of spread:
Treatment given:

OTHER DATA

	Surface—6"	6"—18"	18"—30"
Physical Examination			
Color	light brown	yellow brown	yellow brown
Compactness	hard	hard	hard
Friability	refractory	refractory	refractory
Retentive power	95	95	100
Mechanical Examination			
Coarse gravel	0	0	0
Fine gravel	0	0	0
Coarse sand	0	0	0
Fine sand	0	0	0
Silt	92.5	91.1	92.1
Clay	7.5	8.9	7.9
Chemical Examination			
Organic matter	9.78	10.15	10.77
Total Nitrogen	.14	.32	.04
Potash (K_2O)	.45	.47	.30
Phosphoric acid (P_2O_5)	.35	.08	.12
Lime (CaO)	5.97	3.38	2.52
Magnesia (MgO)	1.40	1.21	1.04
Iron (Fe_2O_3)	5.74	6.97	6.75
Alumina (Al_2O_3)			
Silica, sol. (SiO_2)			
Free Acidity			
Mycological Examination			
Typical Fusaria	No Panama Disease present		
Other Fusaria			

JAMAICA DIVISION

SERIAL NUMBER *429*

Location: *Bound Brook* Farm, Section .
Date: *November, 1916.*
Other distinguishing features: *Rice piece.*
Collector: *L. W. W.*

NATURAL FEATURES

Topography: *Bottom land.*
Drainage: *Good.*
Flood conditions: *None.*
Silt deposition: *None.*
Type of forest growth: *No records.*

CULTIVATION HISTORY

When cleared and planted: *About 1886.*
Number of replantings: *About twelve.* Why? *General practice.*
General condition when in production: *Good.*
Plowed? *Yes.* When? *Yearly.* Grubbed? *Yes.* When? *Yearly.*
Years in bananas: *About 26.* Life of farm: *In reds since 1915.*
Years in bush or fallow: *1904–5 in Guinea grass.*
Other crops grown: *Guinea grass and reds.*

DISEASE HISTORY

When first noted: *None.*
Age of plants when attacked:
Rapidity of spread:
Treatment given:

OTHER DATA

	Surface—6″	6″—18″	18″—30″
Physical Examination			
Color	dark brown	dark brown	dark brown
Compactness	loose	loose	loose
Friability	light	light	light
Retentive power	81	81	81
Mechanical Examination			
Coarse gravel	0	0	0
Fine gravel	0	0	0
Coarse sand	0	0	0
Fine sand	0	0	0
Silt	96.2	95.9	95.2
Clay	3.8	4.1	4.8
Chemical Examination			
Organic matter	7.39	10.83	7.81
Total Nitrogen	.17	.22	.18
Potash (K_2O)	.30	.20	.43
Phosphoric acid (P_2O_5)	.15	.23	.12
Lime (CaO)	1.03	1.09	1.10
Magnesia (MgO)	.50	.61	1.52
Iron (Fe_2O_3)	8.97	8.77	6.93
Alumina (Al_2O_3)			
Silica, sol. (SiO_2)			
Free Acidity			
Mycological Examination			
Typical Fusaria	No Panama Disease present		
Other Fusaria			

JAMAICA DIVISION

SERIAL NUMBER *430*

Location: *Bound Brook* Farm, Section .
Date: *November, 1916.*
Other distinguishing features: *Watson piece.*
Collector: *L. W. W.*

NATURAL FEATURES

Topography: *Bottom land.*
Drainage: *Fair.*
Flood conditions: *None.*
Silt deposition: *None.*
Type of forest growth: *No data.*

CULTIVATION HISTORY

When cleared and planted: *About 1886.*
Number of replantings: *About fifteen.* Why? *General practice.*
General condition when in production: *Good.*
Plowed? *Yes.* When? *Yearly.* Grubbed? *Yes.* When? *Yearly.*
Years in bananas: *About thirty.* Life of farm: *Still producing.*
Years in bush or fallow: *Never.*
Other crops grown: *None.*

DISEASE HISTORY

When first noted: *None.*
Age of plants when attacked:
Rapidity of spread:
Treatment given:

OTHER DATA

	Surface—6"	6"—18"	18"—30"
Physical Examination			
Color	dark brown	dark brown	dark brown
Compactness	loose	loose	loose
Friability	light	light	light
Retentive power	57	54	48
Mechanical Examination			
Coarse gravel	0	0	0
Fine gravel	0	0	0
Coarse sand	0	0	0
Fine sand	0	0	0
Silt	97.0	95.9	96.4
Clay	3.0	4.1	3.6
Chemical Examination			
Organic matter	6.87	8.66	4.43
Total Nitrogen	.14	.09	.03
Potash (K_2O)	.39	.13	.22
Phosphoric acid (P_2O_5)	.08	.09	.21
Lime (CaO)	1.11	1.09	1.95
Magnesia (MgO)	1.26	.62	.90
Iron (Fe_2O_3)	6.72	8.27	6.35
Alumina (Al_2O_3)			
Silica, sol. (SiO_2)			
Free Acidity			
Mycological Examination			
Typical Fusaria	No Panama Disease present		
Other Fusaria			

Average Analyses—Jamaica

Sample	Fine Gravel	Coarse Sand	Fine Sand	Silt	Clay	K_2O	CaO	MgO	Fe_2O_3	P_2O_5	Vol. Mat.	Tot. N	RP
Bushy Park	0	0	0	96.5	3.5	.31	1.09	.57	6.63	.19	5.68	.11	57
Pumpkin Ground	0	0	0	96.6	3.4	.32	2.33	.67	6.32	.25	6.02	.13	59
Cooksons	0	0	0	97.7	2.3	.32	.97	.86	7.33	.21	4.56	.11	46
Bushy Park	0	0	0	96.0	4.0	.20	.66	.95	8.15	.23	6.53	.06	60
Bushy Park	0	0	0	95.6	4.4	.26	1.01	.68	7.09	.11	4.19	.06	54
Salt Ponds	0	10.4	14.8	71.2	3.6	.34	1.78	.62	7.47	.20	5.41	.08	47
Williamsfield	0	0	0	93.5	6.5	.38	1.00	.82	14.07	.96	14.81	.52	83
Williamsfield	0	0	0	91.6	8.4	.35	6.77	1.31	6.24	.21	10.11	.33	87
Windsor	0	0	0	98.1	1.9	.37	.81	.95	7.81	.10	6.14	.11	61
Windsor	0	0	0	97.2	2.8	.36	.45	.86	11.71	.11	9.34	.14	67
Seamans Valley	0	0	0	97.8	2.2	.39	1.71	1.66	7.04	.17	7.52	.15	73
Kildare	0	0	0	98.3	1.7	.32	.38	.38	6.18	.14	6.18	.07	52
Kildare	0	0	0	95.8	4.2	.26	.38	.27	5.77	.14	8.85	.13	69
Paradise	0	0	0	94.0	6.0	.41	3.77	.82	6.83	.23	9.20	.14	73
Paradise	0	0	0	93.5	6.5	.45	1.55	.37	6.12	.19	8.56	.21	91
Hermitage	0	0	0	93.4	6.6	.44	.87	.78	8.36	.16	11.84	.16	72
Hermitage	0	0	0	92.0	8.0	.48	1.24	.72	7.10	.21	9.51	.25	94
Red Hazel	0	0	0	95.3	4.7	.24	1.10	.73	10.13	.09	8.27	.13	73
Fellowship	0	0	0	92.3	7.7	.43	.15	1.41	9.07	.17	9.99	.12	79
Fellowship	0	0	0	96.2	3.8	.33	1.17	.62	8.39	.13	7.93	.20	71
Stanton	0	0	0	94.4	5.6	.39	.85	.65	6.45	.17	6.81	.31	66
Golden Grove	0	0	0	94.1	5.9	.34	2.07	1.13	7.03	.16	7.45	.14	69
Golden Grove	0	0	0	94.1	5.9	.45	2.33	1.25	7.15	.13	7.65	.16	67
Golden Grove	0	0	0	95.2	4.8	.36	2.62	.89	7.17	.16	7.16	.12	59

Wheelerfield . . . . o	0	0	96.0	4.0	.26	20.02	1.49	5.85	.20	7.82	.16	65
Wheelerfield . . . . o	0	0	94.3	5.7	.34	2.73	.95	8.49	.12	7.34	.13	67
Phillipfield . . . . o	0	0	94.2	5.8	.33	7.84	.53	5.77	.15	8.00	.15	77
Pleasant Hill . . . o	0	0	96.8	8.2	.39	3.55	1.18	6.63	.15	10.32	.17	97
Bound Brook . . . o	0	0	95.7	4.3	.31	1.08	.95	8.07	.17	8.97	.19	78
Bound Brook . . . o	0	0	96.3	3.7	.22	1.44	.86	7.19	.13	6.61	.07	52
Whole Division . . . o	0.6	0.8	93.8	4.8	.33	2.88	.87	7.35	.18	7.40	.14	66

AVERAGE OF RESULTS BY DISTRICTS

South Dist. . . . . o	1.7	2.4	92.3	3.6	.29	1.31	.73	7.16	.20	5.39	.09	54
North Dist. . . . . o	0	0	95.0	5.0	.36	1.45	.83	8.03	.20	8.86	.19	73
East Dist. . . . . o	0	0	94.3	5.7	.35	5.88	1.06	6.87	.15	7.96	.15	72

Ratio of Lime to Magnesia

1–1 to 5–1 regarded as normal

401. Bushy Park
1.2–1
1.2–1
4.0–1

402. Pumpkin Ground
3.0–1
3.0–1
4.0–1

403. Cooksons
1.3–1
0.4–1
1.5–1

404. Bushy Park
0.7–1
0.2–1
3.0–1

405. Bushy Park
2.0–1
1.0–1
2.0–1

406. Salt Ponds
4.0–1
2.0–1
3.0–1

407. Williamsfield
3.0–1
.9–1
1.0–1

408. Williamsfield
3.0–1
4.0–1
7.0–1

409. Windsor
1.1–1
.1–1
2.0–1

410. Windsor
.7–1
.5–1
.2–1

411. Seamans Valley
2.0–1
1.0–1
1.0–1

412. Kildare
.9–1
1.1–1
.9–1

413. Kildare
.9–1
2.0–1
1.1–1

414. Paradise
3.0–1
6.0–1
2.0–1

415. Paradise
4.0–1
7.0–1
2.0–1

416. Fellowship
2.0–1
2.0–1
.8–1

417. Hermitage
.1–1
3.0–1
1.2–1

418. Red Hazel
2.0–1
3.0–1
.8–1

419. Fellowship
.1–1
.2–1
.1–1

420. Fellowship
5.0–1
.3–1
3.0–1

421. Stanton
1.0–1
1.0–1
2.0–1

422. Golden Grove
1.1–1
2.0–1
2.0–1

423. Golden Grove
3.0–1
4.0–1
1.0–1

424. Golden Grove
2.0–1
6.0–1
3.0–1

425. Wheelerfield
10.0–1
15.0–1
12.0–1

426. Wheelerfield
3.0–1
2.0–1
2.0–1

427. Phillipfield
4.0–1
3.0–1
2.0–1

428. Pleasant Hill
5.0–1
3.0–1
2.0–1

429. Bound Brook
2.0–1
2.0–1
.9–1

430. Bound Brook
.7–1
2.0–1
1.1–1

Ratio of Organic Matter to Nitrogen

30–1 to 40–1 regarded as normal

401. Bushy Park
45–1
35–1
400–1

402. Pumpkin Ground
50–1
30–1
50–1

403. Cooksons
22–1
30–1
30–1

404. Bushy Park
50–1
70–1

405. Bushy Park
55–1
67–1

406. Salt Ponds
83–1
64–1
100–1

407. Williamsfield
42–1
42–1
51–1

408. Williamsfield
44–1
22–1
31–1

409. Windsor
43–1
40–1
110–1

410. Windsor
24–1
46–1
100–1

411. Seamans Valley
62–1
32–1
71–1

412. Kildare
72–1
45–1
110–1

413. Kildare
48–1
55–1
110–1

414. Paradise
73–1
57–1
88–1

415. Paradise
33–1
33–1
58–1

416. Hermitage
43–1
42–1
100–1

417. Hermitage
38–1
30–1
45–1

418. Red Hazel
64–1
51–1
73–1

419. Fellowship
98–1
87–1
64–1

420. Fellowship
59–1
26–1
51–1

421. Stanton
48–1
88–1
10–1

422. Golden Grove
50–1
42–1
78–1

423. Golden Grove
49–1
39–1
58–1

424. Golden Grove
48–1
42–1
93–1

425. Wheelerfield
33–1
55–1
43–1

426. Wheelerfield
25–1
56–1
66–1

427. Phillipfield
69–1
33–1
280–1

428. Pleasant Hill
69–1
33–1
280–1

429. Bound Brook
43–1
55–1
43–1

430. Bound Brook
49–1
75–1
130–1

Examination of Individual Farms

Bushy Park. A farm with a good record, high in potash and rather low in organic matter and nitrogen.

Pumpkin Ground. Soil of fair depth, high in potash and lime, but rather low in organic matter and nitrogen.

Cooksons. A soil which has been cultivated for many years is now regarded as becoming exhausted. It is of fair depth, high in potash and low in lime and organic matter and very low in total nitrogen.

Bushy Park 2. A soil with a poor record for banana production. It is hard and heavy, with a stiff clay subsoil; only fair drainage. Shows medium potash, low lime, organic matter and phosphoric acid, very low total nitrogen and a rather high iron content. Not to be regarded as a good soil.

Bushy Park 3. Soil with a fair production record but not regarded as first-class banana land. The analysis shows low organic matter and nitrogen, medium potash and low phosphoric acid.

Salt Ponds. Soil of fair depth, high in potash, low in organic matter and nitrogen.

Williamsfield 1. A soil of good depth. It is, however, hard and refractory, and, although high in potash, organic matter, nitrogen and phosphoric acid, will probably be unsatisfactory. This is also very high in iron.

Williamsfield 2. This soil has had an excellent record for three years until destroyed by hurricane. It has the black color characteristic of high humus content and is high in potash, lime and nitrogen.

Windsor 1. A good soil high in potash and nitrogen, but rather low in lime.

Windsor 2. A soil of fair depth, high in potash, low in lime and phosphoric acid. The iron content is very high.

Seamans Valley. A soil of good depth with high potash, low in organic matter.

Kildare 1. Fair depth, high potash, but low in other plant food ingredients.

Kildare 2. Good depth, but of the same general character as the preceding.

Paradise 1. A soil of good depth, high in potash and lime.

Paradise 2. A hard, refractory soil now regarded as exhausted; although the analysis shows high potash and about normal lime, nitrogen and phosphoric acid, the organic matter is low. It seems likely from the survey of the whole situation that the physical character of the soil producing poor rootage is responsible for the apparent exhaustion.

Hermitage 1. A soil of good depth and fair analysis.

Hermitage 2. A hard, refractory soil with a production record which is only fair. The analysis is about average for the Division.

Red Hazel. A very old farm with an excellent record, now regarded as somewhat exhausted. It is low in organic matter, nitrogen and phosphoric acid and high in iron.

Fellowship 1. A hard, refractory soil with no production record. Analysis indicates only fair depth and a great deficiency in lime. The iron is high and the nitrogen low.

Fellowship 2. A soil of good depth, high in potash, but low in total nitrogen and phosphoric acid.

Stanton. An area which has been in bananas over twenty-five years, with a good record, now regarded as becoming exhausted. Potash is high, but the lime, organic matter and nitrogen are low.

Golden Grove 1. In cane over one hundred years and bananas for twenty. This is a soil of good depth now low in organic matter.

Golden Grove 2. Has much the same history as the preceding, but is poorer in phosphoric acid.

Golden Grove 3. Much like the preceding, but indicates greater depth, low in organic matter and nitrogen.

Wheelerfield 1. A soil with an excellent record, very high in lime, low in organic matter.

Wheelerfield 2. A soil of fair depth, low in organic matter, nitrogen and phosphoric acid.

Phillipfield. Good depth, high in potash and very high in lime.

Pleasant Hill. A hard, refractory soil now abandoned for bananas. The depth is good and the analysis shows high potash and lime.

Bound Brook 1. A soil with an excellent record and apparently deep; analysis satisfactory.

Bound Brook 2. A soil somewhat finer than the preceding, low in organic matter, nitrogen and phosphoric acid.

According to the system of classification of Maercker, practically all the Jamaican soils would be regarded as normal to good or rich in character, none being distinctly poor. According to Wohltmann's standards, all would be regarded as rich or good.

Tabular View of Soil Conditions

Explanation of Abbreviations

Potash— h = greater than .30%
l = less than .15%
Lime— h = greater than 2%
l = less than 1%
Organic Matter—h = greater than 15%
l = less than 9%
Nitrogen— h = greater than .30%
l = less than .15%
Phosphoric Acid—h = greater than .30%
l = less than .15%

h = high m = medium r = rapid * = hard, refractory soil
l = low v = very s = slow

Farm	*History*	*Depth*	*Potash*	*Lime*	*Organic Matter*	*Nitrogen*	*Phosphoric Acid*	*Disease Spread*
Bushy Park . . .	good	fair	h	m	l	l	m	
Pumpkin Ground .	good	fair	h	h	l	l–m	m	
Cooksons	good	fair	h	l	l	l	m	
*Bushy Park . . .	fair to poor	fair	m	l	l	vl	m	
Bushy Park . . .	fair	fair	m	m	l	vl	l	r
Salt Ponds . . .	fair	fair	h	m	l	l	m	
Williamsfield . .	–	good	h	m–l	h	h	h	
Williamsfield . .	excellent	deep	h	vh	m–h	h	m	
Windsor	good	good	h	l	l	l	m	
Windsor	good	fair	h	l	m	m–l	l	
Seamans Valley .	good	good	h	m	l	m	m	
Kildare	–	fair	h	l	l	l	l	
Kildare	–	good	h	l	m	l–m	l	
Paradise	–	good	h	l	m	l–m	m	s

Paradise	–	good	h	m	m	m	m
Hermitage	fair	good	h	l	m–h	m	m
Hermitage	fair	good	h	m	m	h	m
Red Hazel	excellent	good	m	m	m	m	l
Fellowship	–	fair	h	vl	m	l–m	m
Fellowship	good	good	h	m	l	m	l
Stanton	excellent	good	h	l	l	h	m
Golden Grove	good	deep	h	h	l	m	m
Golden Grove	good	fair	h	h	l	m	l
Golden Grove	good	good	h	h	l	l–m	m
Wheelerfield	excellent	good	m	vh	l	m	m
Wheelerfield	fair	good	h	h	l	l–m	l
Phillipfield	good	good	h	vh	m	m	m
Pleasant Hill	–	good	h	h	m	m	m
Bound Brook	good	deep	h	m	m	m	m
Bound Brook	good	fair	m	m	l	l	l

s

COLOMBIA DIVISION

The Colombia Division occupies a portion of the extreme eastern part of Colombia. The coastal plain here is largely alluvial in character, made up of tertiary rocks and disintegrated sediment. A portion of this Division is high in soluble salts derived from the breaking down of the particular type of rocks forming the soil and this probably explains the salt spots which occur in certain parts of the Division. The rainfall is limited, at least in portions, requiring irrigation, as in the southern part of Jamaica.

Mechanical Analysis. This shows a considerable sprinkling of gravel and coarse sand. The fine sand is variable in amount and with few exceptions the great bulk of the soil is made up of materials of such fineness as to be classed as silt and clay.

Chemical Character. This Division is characterized by a fairly high potash content, high lime and magnesia, but the ratio between these constituents is in general in favor of the lime. A few of the areas sometimes show a high iron content. The phosphoric acid is satisfactory in amount, but the Division as a whole is deficient in organic matter and total nitrogen.

COLOMBIA DIVISION

SERIAL NUMBER *501*

Location: *Helena* Farm, Section *9*.

Date: *December, 1916.*

Other distinguishing features:

Collector: *L. W. W.*

NATURAL FEATURES

Topography: *Valley.*
Drainage: *Open ditches.*
Flood conditions: *About once a year.*
Silt deposition: *Irregular, about 2 to 3 inches last year.*
Type of forest growth: *Light.*

CULTIVATION HISTORY

When cleared and planted: *1906–7.*
Number of replantings: *One.* Why? *General practice.*
General condition when in production: *Good.*
Plowed? *No.* When? Grubbed? *No.* When?
Years in bananas: *Ten.* Life of farm: *Good production.*
Years in bush or fallow: *Never.*
Other crops grown: *None.*

DISEASE HISTORY

When first noted: *No disease.*
Age of plants when attacked:
Rapidity of spread:
Treatment given:

OTHER DATA

	Surface—6″	6″—18″	18″—30″
Physical Examination			
Color	dark brown	brown	brown
Compactness	fine	fine	fine
Friability	loose	loose	loose
Retentive power	58	44	49
Mechanical Examination			
Coarse gravel	0	0	0
Fine gravel	0	0	0
Coarse sand	0	0	0
Fine sand	.1	.5	.8
Silt	97.6	97.8	95.9
Clay	2.3	1.7	3.3
Chemical Examination			
Organic matter	5.08	3.47	3.81
Total Nitrogen	.16	.11	.06
Potash (K_2O)	.25	.15	.46
Phosphoric acid (P_2O_5)	.16	.25	.33
Lime (CaO)	2.90	2.60	1.65
Magnesia (MgO)	1.27	1.93	1.07
Iron (Fe_2O_3)	7.74	7.56	7.68
Alumina (Al_2O_3)			
Silica, sol. (SiO_2)			
Free Acidity			
Mycological Examination			
Typical Fusaria			
Other Fusaria			

COLOMBIA DIVISION

SERIAL NUMBER *502*

Location: *San Antonio* Farm, Section *31.*

Date: *December, 1916.*

Other distinguishing features:

Collector: *L. W. W.*

NATURAL FEATURES

Topography: *Valley.*
Drainage: *Open ditches.*
Flood conditions: *None.*
Silt deposition: *None.*
Type of forest growth: *Light forest, seashore.*

CULTIVATION HISTORY

When cleared and planted: *1905–6.*
Number of replantings: *Two.* Why? *3 to 4 year rotation.*
General condition when in production: *Fair.*
Plowed? *No.* When? Grubbed? *No.* When?
Years in bananas: *Nine.* Life of farm: *Only fair production.*
Years in bush or fallow: *Never.*
Other crops grown: *None.*

DISEASE HISTORY

When first noted: *No disease.*
Age of plants when attacked:
Rapidity of spread:
Treatment given:

OTHER DATA

	Surface—6″	6″—18″	18″—30″
Physical Examination			
Color	dark brown	brown	brown
Compactness	fine	fine	fine
Friability	loose	loose	loose
Retentive power	48	52	22
Mechanical Examination			
Coarse gravel	0	0	0
Fine gravel	0	0	0
Coarse sand	0	0	.9
Fine sand	.2	1.9	34.2
Silt	98.4	96.3	64.1
Clay	1.4	1.8	.8
Chemical Examination			
Organic matter	4.56	3.07	1.45
Total Nitrogen	.15	.01	.03
Potash (K_2O)	.41	1.00	.89
Phosphoric acid (P_2O_5)	.16	.27	.26
Lime (CaO)	3.12	1.71	1.95
Magnesia (MgO)	3.09	1.00	.69
Iron (Fe_2O_3)	8.92	6.94	5.80
Alumina (Al_2O_3)			
Silica, sol. (SiO_2)			
Free Acidity			
Mycological Examination			
Typical Fusaria			
Other Fusaria			

COLOMBIA DIVISION

SERIAL NUMBER *503*

Location: *Magola* Farm, Section *10.* Date: *December, 1916.*

Other distinguishing features: Collector: *L. W. W.*

NATURAL FEATURES

Topography: *Valley.*
Drainage: *Open ditches.*
Flood conditions: *None.*
Silt deposition: *None.*
Type of forest growth: *Second growth.*

CULTIVATION HISTORY

When cleared and planted: *First cleared 20 years ago, sugar cane planted.*
Number of replantings: *Bananas, 1908. Replanted once.* Why?
General condition when in production: *Good.*
Plowed? *No.* When? Grubbed? *No.* When?
Years in bananas: *Eight.* Life of farm: *Production still good.*
Years in bush or fallow: *Never.*
Other crops grown: *None.*

DISEASE HISTORY

When first noted: *No disease.*
Age of plants when attacked:
Rapidity of spread:
Treatment given:

OTHER DATA

	Surface—6"	6"—18"	18"—30"
Physical Examination			
Color	dark brown	brown	brown
Compactness	fine	fine	fine
Friability	loose	loose	loose
Retentive power	52	35	30
Mechanical Examination			
Coarse gravel	0	0	0
Fine gravel	0	0	0
Coarse sand	0	0	0
Fine sand	.2	.6	3.0
Silt	97.5	98.4	96.0
Clay	2.3	1.0	1.0
Chemical Examination			
Organic matter	6.18	2.86	2.30
Total Nitrogen	.02	.06	.06
Potash (K_2O)	.34	.05	1.26
Phosphoric acid (P_2O_5)	0	.26	.29
Lime (CaO)	4.85	2.87	1.99
Magnesia (MgO)	.79	1.61	.93
Iron (Fe_2O_3)	6.88	7.06	6.66
Alumina (Al_2O_3)			
Silica, sol. (SiO_2)			
Free Acidity			
Mycological Examination			
Typical Fusaria			
Other Fusaria			

COLOMBIA DIVISION

SERIAL NUMBER *504*

Location: *Ceibales* Farm, Section *18*. Date: *December, 1916.*

Other distinguishing features: Collector: *L. W. W.*

NATURAL FEATURES

Topography: *Valley.*
Drainage: *Open ditches.*
Flood conditions: *None.*
Silt deposition: *None.*
Type of forest growth: *Light seashore vegetation.*

CULTIVATION HISTORY

When cleared and planted: *1900–1.*
Number of replantings: *Three.* Why? *General practice.*
General condition when in production: *Good.*
Plowed? *No.* When? Grubbed? *No.* When?
Years in bananas: *Fifteen.* Life of farm: *Production still good.*
Years in bush or fallow: *Never.*
Other crops grown: *None.*

DISEASE HISTORY

When first noted: *No disease.*
Age of plants when attacked:
Rapidity of spread:
Treatment given:

OTHER DATA

	Surface—6"	6"—18"	18"—30"
PHYSICAL EXAMINATION			
Color	dark brown	brown	brown
Compactness	fine	fine	fine
Friability	light	light	light
Retentive power	62	57	33
MECHANICAL EXAMINATION			
Coarse gravel	0	0	0
Fine gravel	0	0	0
Coarse sand	0	0	0
Fine sand	.6	.2	1.6
Silt	97.3	99.3	97.6
Clay	2.1	.5	.8
CHEMICAL EXAMINATION			
Organic matter	8.57	3.14	2.22
Total Nitrogen	.36	.01	.01
Potash (K_2O)	.17	.52	.59
Phosphoric acid (P_2O_5)	.48	0	.29
Lime (CaO)	2.65	3.47	1.79
Magnesia (MgO)	1.10	1.09	.77
Iron (Fe_2O_3)	5.73	7.04	6.04
Alumina (Al_2O_3)			
Silica, sol. (SiO_2)			
Free Acidity			
MYCOLOGICAL EXAMINATION			
Typical Fusaria			
Other Fusaria			

COLOMBIA DIVISION

SERIAL NUMBER *505*

Location: *Olivo* Farm, Section *3*.
Other distinguishing features: *Spot salitrous, abandoned.*

Date: *December, 1916.*
Collector: *L. W. W.*

NATURAL FEATURES

Topography: *Valley.*
Drainage: *Open ditches.*
Flood conditions: *None.*
Silt deposition: *None.*
Type of forest growth: *Light seacoast growth.*

CULTIVATION HISTORY

When cleared and planted: *1903.*
Number of replantings: *Three.* Why? *General practice.*
General condition when in production: *Fair.*
Plowed? *No.* When? Grubbed? *No.* When?
Years in bananas: *Thirteen.* Life of farm: *Production only fair.*
Years in bush or fallow: *Never.*
Other crops grown: *None.*

DISEASE HISTORY

When first noted: *No disease.*
Age of plants when attacked:
Rapidity of spread:
Treatment given:

OTHER DATA

This sample was taken in an area which appears to be too heavily charged with saline content for good production.

	Surface—6"	6"—18"	18"—30"
Physical Examination			
Color	dark brown	brown	brown
Compactness	fine	fine	fine
Friability	light	light	light
Retentive power	55	36	40
Mechanical Examination			
Coarse gravel	0	0	0
Fine gravel	0	0	0
Coarse sand	0	0	0
Fine sand	.4	2.8	13.5
Silt	92.8	95.7	85.8
Clay	6.8	1.5	.7
Chemical Examination			
Organic matter	6.22	2.95	1.99
Total Nitrogen	.22	.06	.01
Potash (K_2O)	.49	.17	.58
Phosphoric acid (P_2O_5)	.27	.01	.24
Lime (CaO)	2.84	2.40	1.52
Magnesia (MgO)	2.72	2.65	.87
Iron (Fe_2O_3)	6.80	5.49	6.22
Alumina (Al_2O_3)			
Silica, sol. (SiO_2)			
Free Acidity			
Mycological Examination			
Typical Fusaria			
Other Fusaria			

COLOMBIA DIVISION

SERIAL NUMBER *506*

Location: *Esperanza* Farm, Section *1.* Date: *December, 1916.*

Other distinguishing features: Collector: *L. W. W.*

NATURAL FEATURES

Topography: *Valley.*
Drainage: *Open ditches and natural sources.*
Flood conditions: *None.*
Silt deposition: *None.*
Type of forest growth: *Unknown; no forest for over 25 years.*

CULTIVATION HISTORY

When cleared and planted: *Tobacco, sugar cane and plantains first grown.*
Number of replantings: *Bananas, 1906.* Why? *Replanted twice.*
General condition when in production: *Good.*
Plowed? *No.* When? Grubbed? *No.* When?
Years in bananas: *Ten.* Life of farm: *Production holds good.*
Years in bush or fallow: *Never.*
Other crops grown: *None.*

DISEASE HISTORY

When first noted: *No disease.*
Age of plants when attacked:
Rapidity of spread:
Treatment given:

OTHER DATA

	Surface—6"	6"—18"	18"—30"
Physical Examination			
Color	dark brown	brown	brown
Compactness	fine	fine	fine
Friability	light	light	light
Retentive power	51	41	29
Mechanical Examination			
Coarse gravel	0	0	0
Fine gravel	0	0	0
Coarse sand	0	0	0
Fine sand	1.2	1.3	1.6
Silt	95.1	88.7	97.2
Clay	3.7	10.0	1.2
Chemical Examination			
Organic matter	5.38	2.42	1.48
Total Nitrogen	.01	.01	.05
Potash (K_2O)	.55	.61	.27
Phosphoric acid (P_2O_5)	.07	.35	0
Lime (CaO)	1.92	2.24	2.60
Magnesia (MgO)	.62	.86	1.85
Iron (Fe_2O_3)	5.74	6.06	9.24
Alumina (Al_2O_3)			
Silica, sol. (SiO_2)			
Free Acidity			
Mycological Examination			
Typical Fusaria			
Other Fusaria			

COLOMBIA DIVISION

SERIAL NUMBER *507*

Location: *Lucia* Farm, Section *7*.
Other distinguishing features:

Date: *December, 1916.*
Collector: *L. W. W.*

NATURAL FEATURES

Topography: *Valley.*
Drainage: *Open ditches.*
Flood conditions: *None.*
Silt deposition: *None.*
Type of forest growth: *Heavy.*

CULTIVATION HISTORY

When cleared and planted: *1888–9.*
Number of replantings: *About ten.* Why? *General practice.*
General condition when in production: *Fair.*
Plowed? *No.* When? Grubbed? *No.* When?
Years in bananas: *28.* Life of farm: *Still producing.*
Years in bush or fallow: *Never.*
Other crops grown: *None.*

DISEASE HISTORY

When first noted: *No disease.*
Age of plants when attacked:
Rapidity of spread:
Treatment given:

OTHER DATA

This is the oldest banana cultivation in the division. It is still in good condition and the sample was located here to get data on a soil that has lasted so long.

	Surface—6"	6"—18"	18"—30"
Physical Examination			
Color	dark brown	brown	light brown
Compactness	fine	fine	fine
Friability	light	light	light
Retentive power	59	46	35
Mechanical Examination			
Coarse gravel	0	0	0
Fine gravel	0	0	0
Coarse sand	0	0	0
Fine sand	.3	.3	.4
Silt	95.0	96.9	98.0
Clay	4.7	2.8	1.6
Chemical Examination			
Organic matter	8.73	4.80	2.79
Total Nitrogen	.01	.12	.05
Potash (K_2O)	.36	.68	.38
Phosphoric acid (P_2O_5)	.28	.32	.25
Lime (CaO)	2.17	2.32	1.57
Magnesia (MgO)	1.47	2.35	1.15
Iron (Fe_2O_3)	7.50	7.74	7.24
Alumina (Al_2O_3)			
Silica, sol. (SiO_2)			
Free Acidity			
Mycological Examination			
Typical Fusaria			
Other Fusaria			

COLOMBIA DIVISION

SERIAL NUMBER *508*

Location: *Elias tract* Farm, Section ; *Pole 1027.* Date: *December, 1916.*

Other distinguishing features: *Woodland.* Collector: *L. W. W.*

NATURAL FEATURES

Topography: *Hilltop.*
Drainage: *Natural.*
Flood conditions: *About once a year.*
Silt deposition: *Probably some.*
Type of forest growth: *Light forest, heavy undergrowth.*

CULTIVATION HISTORY

When cleared and planted: *Not cleared, but large trees have been cut and patches here and there planted with local food crops.*
Number of replantings: Why?
General condition when in production:
Plowed? When? Grubbed? When?
Years in bananas: Life of farm:
Years in bush or fallow:
Other crops grown:

DISEASE HISTORY

When first noted:
Age of plants when attacked:
Rapidity of spread:
Treatment given:

OTHER DATA

	Surface—6"	6"—18"	18"—30"
PHYSICAL EXAMINATION			
Color	dark brown	brown	light brown
Compactness	fine, firm	fine, firm	fine, firm
Friability	light	light	light
Retentive power	46	34	34
MECHANICAL EXAMINATION			
Coarse gravel	0	0	0
Fine gravel	0	1.0	.2
Coarse sand	0	.4	7.4
Fine sand	10.0	23.7	35.2
Silt	87.8	73.6	55.3
Clay	2.2	1.3	1.9
CHEMICAL EXAMINATION			
Organic matter	4.77	3.05	3.04
Total Nitrogen	.20	.11	.06
Potash (K_2O)	.45	.16	.42
Phosphoric acid (P_2O_5)	.25	.25	.21
Lime (CaO)	2.63	1.99	1.50
Magnesia (MgO)	1.21	1.78	1.38
Iron (Fe_2O_3)	5.49	5.62	7.00
Alumina (Al_2O_3)			
Silica, sol. (SiO_2)			
Free Acidity			
MYCOLOGICAL EXAMINATION			
Typical Fusaria			
Other Fusaria			

COLOMBIA DIVISION

SERIAL NUMBER *509*

Location: *Elias tract* Farm, Section *; Pole 1047.* Date: *December, 1916.*

Other distinguishing features: *Woodland.* Collector: *L. W. W.*

NATURAL FEATURES

Topography: *Valley.*
Drainage: *Natural.*
Flood conditions: *About once a year.*
Silt deposition: *Probably some.*
Type of forest growth: *Light with heavy underbrush.*

CULTIVATION HISTORY

When cleared and planted: *See 508, no bananas grown here.*
Number of replantings: Why?
General condition when in production:
Plowed? When? Grubber? When?
Years in bananas: Life of farm:
Years in bush or fallow:
Other crops grown:

DISEASE HISTORY

When first noted:
Age of plants when attacked:
Rapidity of spread:
Treatment given:

OTHER DATA

	Surface—6"	6"—18"	18"—30"
Physical Examination			
Color	dark brown	light brown	light brown
Compactness	fine, firm	fine, firm	coarse, loose
Friability	light	light	refractory
Retentive power	60	51	35
Mechanical Examination			
Coarse gravel	0	0	0
Fine gravel	0	0	.4
Coarse sand	.1	0	7.5
Fine sand	3.7	6.5	40.5
Silt	93.6	91.3	49.2
Clay	2.6	2.2	2.4
Chemical Examination			
Organic matter	7.66	5.42	3.65
Total Nitrogen	.05	.01	.08
Potash (K_2O)	.43	.15	.52
Phosphoric acid (P_2O_5)	.16	.13	.20
Lime (CaO)	2.62	1.75	1.82
Magnesia (MgO)	1.80	2.17	.90
Iron (Fe_2O_3)	7.32	7.32	6.62
Alumina (Al_2O_3)			
Silica, sol. (SiO_2)			
Free Acidity			
Mycological Examination			
Typical Fusaria			
Other Fusaria			

COLOMBIA DIVISION

SERIAL NUMBER *510*

Location: *Canobobal* Farm, Section *; Pasture.* Date: *December, 1916.*

Other distinguishing features: *Opposite Delia Ester house.* Collector: *L. W. W.*

NATURAL FEATURES

Topography: *Valley.*
Drainage: *Natural.*
Flood conditions: *Every four or five years.*
Silt deposition: *Very light cover.*
Type of forest growth: *Very heavy.*

CULTIVATION HISTORY

When cleared and planted: *Unknown; probably more than ten years.*
Number of replantings: *No bananas.* Why?
General condition when in production: *At present used for cattle.*
Plowed? *No.* When? Grubbed? *No.* When?
Years in bananas: *Never.* Life of farm:
Years in bush or fallow:
Other crops grown: *At one time in cacao.*

DISEASE HISTORY

When first noted:
Age of plants when attacked:
Rapidity of spread:
Treatment given:

OTHER DATA

	Surface—6"	6"—18"	18"—30"
Physical Examination			
Color	brown	brown	brown
Compactness	fine, firm	fine, firm	fine, firm
Friability	stiff	stiff	stiff
Retentive power	65	58	53
Mechanical Examination			
Coarse gravel	0	0	0
Fine gravel	0	0	0
Coarse sand	0	0	0
Fine sand	.1	.1	0
Silt	94.9	96.3	96.5
Clay	5.0	3.6	3.5
Chemical Examination			
Organic matter	8.64	4.92	4.62
Total Nitrogen	.01	.01	.10
Potash (K_2O)	.48	.33	.29
Phosphoric acid (P_2O_5)	.21	0	0
Lime (CaO)	1.92	2.51	3.04
Magnesia (MgO)	1.35	1.41	1.86
Iron (Fe_2O_3)	8.45	9.24	8.72
Alumina (Al_2O_3)			
Silica, sol. (SiO_2)			
Free Acidity			
Mycological Examination			
Typical Fusaria			
Other Fusaria			

COLOMBIA DIVISION

SERIAL NUMBER *511*

Location: *Canobobal* Farm, Section ; *House.* Date: *December, 1916.*

Other distinguishing features: Collector: *L. W. W.*

NATURAL FEATURES

Topography: *Valley.*
Drainage: *Natural.*
Flood conditions: *About once a year.*
Silt deposition: *Very little.*
Type of forest growth: *Second growth.*

CULTIVATION HISTORY

When cleared and planted: *At least fifteen years ago, never planted in bananas.*
Number of replantings: Why?
General condition when in production: *Some yucca and cane planted by squatters.*
Plowed? When? Grubbed? When?
Years in bananas: Life of farm:
Years in bush or fallow:
Other crops grown:

DISEASE HISTORY

When first noted:
Age of plants when attacked:
Rapidity of spread:
Treatment given:

OTHER DATA

	Surface—6"	6"—18"	18"—30"
Physical Examination			
Color	brown	brown	brown
Compactness	coarse	fine, firm	fine, firm
Friability	stony	light	light
Retentive power	61	60	49
Mechanical Examination			
Coarse gravel	0	0	0
Fine gravel	1.1	0	0
Coarse sand	1.4	0	0
Fine sand	2.0	0.1	1.6
Silt	92.0	95.7	94.4
Clay	3.5	4.2	4.0
Chemical Examination			
Organic matter	6.49	5.76	4.68
Total Nitrogen	.22	.14	.08
Potash (K_2O)	.35	.21	.04
Phosphoric acid (P_2O_5)	.23	.25	.23
Lime (CaO)	2.03	3.09	2.86
Magnesia (MgO)	2.42	2.23	2.24
Iron (Fe_2O_3)	9.65	11.11	10.28
Alumina (Al_2O_3)			
Silica, sol. (SiO_2)			
Free Acidity			
Mycological Examination			
Typical Fusaria			
Other Fusaria			

COLOMBIA DIVISION

SERIAL NUMBER *512*

Location: *Latal* Farm, Section *1F.*

Date: *December, 1916.*

Other distinguishing features:

Collector: *L. W. W.*

NATURAL FEATURES

Topography: *Valley.*
Drainage: *Open ditches.*
Flood conditions: *None.*
Silt deposition: *None.*
Type of forest growth: *Heavy.*

CULTIVATION HISTORY

When cleared and planted: *1914.*
Number of replantings: *None.* Why?
General condition when in production: *Good.*
Plowed? *No.* When? Grubbed? *No.* When?
Years in bananas: *Three.* Life of farm:
Years in bush or fallow: *Never.*
Other crops grown: *None.*

DISEASE HISTORY

When first noted: *No disease.*
Age of plants when attacked:
Rapidity of spread:
Treatment given:

OTHER DATA

	Surface—6"	6"—18"	18"—30"
Physical Examination			
Color	brown	brown	brown
Compactness	fine, loose	fine, loose	fine, loose
Friability	light	light	light
Retentive power	69	67	51
Mechanical Examination			
Coarse gravel	0	0	0
Fine gravel	0	0	0
Coarse sand	0	0	0
Fine sand	.8	1.7	1.5
Silt	96.1	95.2	96.0
Clay	3.1	3.1	2.5
Chemical Examination			
Organic matter	8.98	5.48	3.69
Total Nitrogen	.28	.18	.06
Potash (K_2O)	.35	.47	.09
Phosphoric acid (P_2O_5)	0	0	.26
Lime (CaO)	3.19	3.04	2.88
Magnesia (MgO)	1.00	1.94	1.87
Iron (Fe_2O_3)	5.69	6.28	7.27
Alumina (Al_2O_3)			
Silica, sol. (SiO_2)			
Free Acidity			
Mycological Examination			
Typical Fusaria			
Other Fusaria			

COLOMBIA DIVISION

SERIAL NUMBER *513*

Location: *Macondo* Farm, Section *9; Upper.* Date: *December, 1916.*

Other distinguishing features: Collector: *L. W. W.*

NATURAL FEATURES

Topography: *Valley.*
Drainage: *Open ditches.*
Flood conditions: *None.*
Silt deposition: *None.*
Type of forest growth: *Heavy.*

CULTIVATION HISTORY

When cleared and planted: *1909–10.*
Number of replantings: *One.* Why? *General practice.*
General condition when in production: *Good.*
Plowed? *No.* When? Grubbed? *No.* When?
Years in bananas: *Seven.* Life of farm: *Production still good.*
Years in bush or fallow: *Never.*
Other crops grown: *None.*

DISEASE HISTORY

When first noted: *No disease.*
Age of plants when attacked:
Rapidity of spread:
Treatment given:

OTHER DATA

	Surface—6"	6"—18"	18"—30"
Physical Examination			
Color	dark brown	brown	brown
Compactness	fine, firm	fine, firm	fine, firm
Friability	light	light	light
Retentive power	60	54	52
Mechanical Examination			
Coarse gravel	0	0	0
Fine gravel	0	0	0
Coarse sand	0	0	0
Fine sand	.3	1.1	.6
Silt	95.8	95.0	96.7
Clay	3.9	3.9	2.7
Chemical Examination			
Organic matter	7.56	6.56	5.67
Total Nitrogen	.21	.12	.07
Potash (K_2O)	.21	.10	.19
Phosphoric acid (P_2O_5)	.21	.20	.13
Lime (CaO)	2.53	1.76	1.64
Magnesia (MgO)	2.40	1.49	.57
Iron (Fe_2O_3)	4.64	7.02	8.47
Alumina (Al_2O_3)			
Silica, sol. (SiO_2)			
Free Acidity			
Mycological Examination			
Typical Fusaria			
Other Fusaria			

COLOMBIA DIVISION

SERIAL NUMBER *514*

Location: *Macondo* Farm, Section *20; Upper.* Date: *December, 1916.*

Other distinguishing features: *Abandoned.* Collector: *L. W. W.*

NATURAL FEATURES

Topography: *Valley.*
Drainage: *Open ditches.*
Flood conditions: *None.*
Silt deposition: *None.*
Type of forest growth: *Heavy.*

CULTIVATION HISTORY

When cleared and planted: *1909–10.*
Number of replantings: *None.* Why? *Unproductive.*
General condition when in production: *Bad.*
Plowed? *Yes.* When? *1911.* Grubbed? *No.* When?
Years in bananas: *Three.* Life of farm: *Abandoned three years ago.*
Years in bush or fallow: *Three.*
Other crops grown: *None.*

DISEASE HISTORY

When first noted: *No disease.*
Age of plants when attacked:
Rapidity of spread:
Treatment given:

OTHER DATA

	Surface—6"	6"—18"	18"—30"
PHYSICAL EXAMINATION			
Color	brown	light brown	brown
Compactness	hard	hard	hard
Friability	stiff clay	stiff clay	stiff clay
Retentive power	57	58	45
MECHANICAL EXAMINATION			
Coarse gravel	0	0	0
Fine gravel	0	0	0
Coarse sand	0	0	0
Fine sand	1.7	.5	19.4
Silt	94.4	96.6	78.7
Clay	3.9	2.9	1.9
CHEMICAL EXAMINATION			
Organic matter	6.72	6.00	5.40
Total Nitrogen	.01	.01	.06
Potash (K_2O)	.85	.74	.62
Phosphoric acid (P_2O_5)	.23	.20	.15
Lime (CaO)	2.56	2.30	1.63
Magnesia (MgO)	.64	.96	.79
Iron (Fe_2O_3)	8.61	8.92	8.19
Alumina (Al_2O_3)			
Silica, sol. (SiO_2)			
Free Acidity			
MYCOLOGICAL EXAMINATION			
Typical Fusaria			
Other Fusaria			

COLOMBIA DIVISION

SERIAL NUMBER *515*

Location: *Florida* Farm, Section *15*. Date: *December, 1916.*

Other distinguishing features: Collector: *L. W. W.*

NATURAL FEATURES

Topography: *Valley.*
Drainage: *Open ditches.*
Flood conditions: *None.*
Silt deposition: *None.*
Type of forest growth: *Heavy.*

CULTIVATION HISTORY

When cleared and planted: *1910.*
Number of replantings: *One.* Why? *General practice.*
General condition when in production: *Fair.*
Plowed? *No.* When? Grubbed? *No.* When?
Years in bananas: *Seven.* Life of farm: *Production only fair.*
Years in bush or fallow: *Never.*
Other crops grown: *None.*

DISEASE HISTORY

When first noted: *No disease.*
Age of plants when attacked:
Rapidity of spread:
Treatment given:

OTHER DATA

	Surface—6"	6"—18"	18"—30"
PHYSICAL EXAMINATION			
Color	dark brown	light brown	light brown
Compactness	fairly hard	fairly hard	fairly hard
Friability	stiff	stiff	stiff
Retentive power	41	36	36
MECHANICAL EXAMINATION			
Coarse gravel	0	0	0
Fine gravel	0	0	0
Coarse sand	.4	0	0
Fine sand	10.7	18.0	.1
Silt	86.4	80.8	97.4
Clay	2.5	1.2	2.5
CHEMICAL EXAMINATION			
Organic matter	3.79	2.45	4.14
Total Nitrogen	.12	.06	.08
Potash (K_2O)	.22	.44	.40
Phosphoric acid (P_2O_5)	.25	.25	.19
Lime (CaO)	4.19	2.99	3.44
Magnesia (MgO)	.99	1.89	1.95
Iron (Fe_2O_3)	6.15	6.54	8.03
Alumina (Al_2O_3)			
Silica, sol. (SiO_2)			
Free Acidity			
MYCOLOGICAL EXAMINATION			
Typical Fusaria			
Other Fusaria			

COLOMBIA DIVISION

SERIAL NUMBER *516*

Location: *Esperanza* Farm, Section .

Date: *December, 1916.*

Other distinguishing features: *Opposite bridge 31.*

Collector: *L. W. W.*

NATURAL FEATURES

Topography: *Valley.*
Drainage: *Open ditches.*
Flood conditions: *Yearly.*
Silt deposition: *Very little.*
Type of forest growth: *Heavy.*

CULTIVATION HISTORY

When cleared and planted: *1912.*
Number of replantings: *None.* Why? *Abandoned.*
General condition when in production: *Bad.*
Plowed? *No.* When? Grubbed? *No.* When?
Years in bananas: *Four.* Life of farm: *Gave poor results, abandoned.*
Years in bush or fallow: *One.*
Other crops grown: *None.*

DISEASE HISTORY

When first noted: *No disease.*
Age of plants when attacked:
Rapidity of spread:
Treatment given:

OTHER DATA

	Surface—6"	6"—18"	18"—30"
PHYSICAL EXAMINATION			
Color	dark brown	light brown	light brown
Compactness	hard	hard	hard
Friability	refractory	refractory	refractory
Retentive power	69	69	65
MECHANICAL EXAMINATION			
Coarse gravel	0	0	0
Fine gravel	0	0	0
Coarse sand	0	0	0
Fine sand	.3	.1	0
Silt	95.0	92.9	93.4
Clay	4.7	7.0	6.6
CHEMICAL EXAMINATION			
Organic matter	10.10	8.48	6.63
Total Nitrogen	.01	.16	.07
Potash (K_2O)	.58	.16	.14
Phosphoric acid (P_2O_5)	.22	.16	.10
Lime (CaO)	3.09	3.37	2.76
Magnesia (MgO)	1.57	1.81	1.83
Iron (Fe_2O_3)	9.34	8.34	7.30
Alumina (Al_2O_3)			
Silica, sol. (SiO_2)			
Free Acidity			
MYCOLOGICAL EXAMINATION			
Typical Fusaria			
Other Fusaria			

COLOMBIA DIVISION

SERIAL NUMBER *517*

Location: *Latal* Farm, Section *; Woodland.* Date: *December, 1916.*

Other distinguishing features: *Opposite Kil. 1 1/2.* Collector: *L. W. W.*

NATURAL FEATURES

Topography: *Valley.*
Drainage: *Natural.*
Flood conditions: *None.*
Silt deposition: *None.*
Type of forest growth: *Heavy.*

CULTIVATION HISTORY

When cleared and planted: *Not cleared.*
Number of replantings: Why?
General condition when in production:
Plowed? When? Grubbed? When?
Years in bananas: Life of farm:
Years in bush or fallow:
Other crops grown:

DISEASE HISTORY

When first noted:
Age of plants when attacked:
Rapidity of spread:
Treatment given:

OTHER DATA

Bananas planted in another portion of this same tract have been in good production for about eight years. There are about 280 hectares of this tract still available.

	Surface—6"	6"—18"	18"—30"
Physical Examination			
Color	dark brown	brown	brown
Compactness	loose	loose	loose
Friability	light	light	light
Retentive power	71	51	40
Mechanical Examination			
Coarse gravel	0	0	0
Fine gravel	0	2.4	0
Coarse sand	0	1.8	.5
Fine sand	8.2	12.8	15.4
Silt	88.5	81.3	82.7
Clay	3.3	1.7	1.4
Chemical Examination			
Organic matter	7.92	3.45	2.74
Total Nitrogen	.26	.10	.04
Potash (K_2O)	.17	.17	.16
Phosphoric acid (P_2O_5)	.25	.29	.19
Lime (CaO)	2.99	2.47	1.79
Magnesia (MgO)	1.73	1.96	1.33
Iron (Fe_2O_3)	5.27	6.27	4.99
Alumina (Al_2O_3)			
Silica, sol. (SiO_2)			
Free Acidity			
Mycological Examination			
Typical Fusaria			
Other Fusaria			

COLOMBIA DIVISION

SERIAL NUMBER *518*

Location: *Latal* Farm, Section ; *Woodland.*

Date: *December, 1916.*

Other distinguishing features: *Opp. Kil. 1.*

Collector: *L. W. W.*

NATURAL FEATURES

Topography: *Valley.*
Drainage: *Natural.*
Flood conditions: *None.*
Silt deposition: *None.*
Type of forest growth: *Heavy.*

CULTIVATION HISTORY

When cleared and planted: *Not cleared.*
Number of replantings: Why?
General condition when in production:
Plowed? When? Grubbed? When?
Years in bananas: Life of farm:
Years in bush or fallow:
Other crops grown:

DISEASE HISTORY

When first noted:
Age of plants when attacked:
Rapidity of spread:
Treatment given:

OTHER DATA

Same tract as 517.

	Surface—6"	6"—18"	18"—30"
Physical Examination			
Color	brown	light brown	light brown
Compactness	loose	loose	loose
Friability	light	light	light
Retentive power	57	46	32
Mechanical Examination			
Coarse gravel	0	0	0
Fine gravel	1.0	1.0	2.1
Coarse sand	1.3	1.8	13.8
Fine sand	7.3	8.2	37.6
Silt	87.3	86.7	45.3
Clay	3.1	2.3	1.2
Chemical Examination			
Organic matter	6.68	3.93	2.89
Total Nitrogen	.19	.02	.05
Potash (K_2O)	.26	.15	.70
Phosphoric acid (P_2O_5)	.52	.28	.02
Lime (CaO)	10.69	2.24	2.08
Magnesia (MgO)	1.85	1.96	1.43
Iron (Fe_2O_3)	5.07	6.23	6.34
Alumina (Al_2O_3)			
Silica, sol. (SiO_2)			
Free Acidity			
Mycological Examination			
Typical Fusaria			
Other Fusaria			

COLOMBIA DIVISION

SERIAL NUMBER *519*

Location: *Catalina* Farm, Section .

Date: *December, 1916.*

Other distinguishing features: *Kil. 64, F.C.S.M.*

Collector: *L. W. W.*

NATURAL FEATURES

Topography: *Valley.*
Drainage: *Open ditches.*
Flood conditions: *None.*
Silt deposition: *None.*
Type of forest growth: *Heavy.*

CULTIVATION HISTORY

When cleared and planted: *1894–5.*
Number of replantings: *Two.* Why? *General practice.*
General condition when in production: *Good for a few years.*
Plowed? *No.* When? Grubbed? *No.* When?
Years in bananas: *Fifteen.* Life of farm: *Abandoned about six years ago.*
Years in bush or fallow: *Never.*
Other crops grown: *None.*

DISEASE HISTORY

When first noted: *No disease.*
Age of plants when attacked:
Rapidity of spread:
Treatment given:

OTHER DATA

Bananas played out and were abandoned about six years ago. Land now used as a pasture.

	Surface—6″	6″—18″	18″—30″
Physical Examination			
Color	light brown	light brown	light brown
Compactness	fine, firm	fine, firm	fine, firm
Friability	fairly stiff	fairly stiff	fairly stiff
Retentive power	52	56	71
Mechanical Examination			
Coarse gravel	0	0	0
Fine gravel	0	0	0
Coarse sand	0	0	0
Fine sand	5.7	2.2	1.1
Silt	92.6	95.8	96.5
Clay	1.7	2.0	2.4
Chemical Examination			
Organic matter	3.61	3.86	7.57
Total Nitrogen	.01	.01	.01
Potash (K_2O)	.86	.72	.39
Phosphoric acid (P_2O_5)	.01	.23	.28
Lime (CaO)	2.15	2.16	1.68
Magnesia (MgO)	.70	2.18	2.03
Iron (Fe_2O_3)	7.37	7.98	7.70
Alumina (Al_2O_3)			
Silica, sol. (SiO_2)			
Free Acidity			
Mycological Examination			
Typical Fusaria			
Other Fusaria			

COLOMBIA DIVISION

SERIAL NUMBER *520*

Location: *Miranda Lot* Farm, Section *; Woodland.*

Date: *December, 1916.*

Other distinguishing features: *Opposite Correa tram.*

Collector: *L. W. W.*

NATURAL FEATURES

Topography: *Valley.*
Drainage: *Natural.*
Flood conditions: *None.*
Silt deposition: *None.*
Type of forest growth: *Heavy.*

CULTIVATION HISTORY

When cleared and planted: *Never cleared.*
Number of replantings: Why?
General condition when in production:
Plowed? When? Grubbed? When?
Years in bananas: Life of farm:
Years in bush or fallow:
Other crops grown:

DISEASE HISTORY

When first noted:
Age of plants when attacked:
Rapidity of spread:
Treatment given:

OTHER DATA

See note under 521.

	Surface—6"	6"—18"	18"—30"
PHYSICAL EXAMINATION			
Color	dark brown	dark brown	brown
Compactness	loose	loose	loose
Friability	sandy	sandy	sandy
Retentive power	51	50	36
MECHANICAL EXAMINATION			
Coarse gravel	0	0	0
Fine gravel	0	0	6.9
Coarse sand	0	0	16.5
Fine sand	20.9	7.0	34.9
Silt	78.0	91.9	40.5
Clay	1.1	1.1	1.2
CHEMICAL EXAMINATION			
Organic matter	4.27	3.14	1.46
Total Nitrogen	.14	.10	.04
Potash (K_2O)	.68	1.95	.32
Phosphoric acid (P_2O_5)	.25	.22	.28
Lime (CaO)	2.61	2.52	1.94
Magnesia (MgO)	1.23	1.86	1.62
Iron (Fe_2O_3)	6.84	8.58	7.99
Alumina (Al_2O_3)			
Silica, sol. (SiO_2)			
Free Acidity			
MYCOLOGICAL EXAMINATION			
Typical Fusaria			
Other Fusaria			

COLOMBIA DIVISION

SERIAL NUMBER *521*

Location: *Miranda Lot* Farm, Section *; Woodland.* Date: *December, 1916.*

Other distinguishing features: *North of Correa tram.* Collector: *L. W. W.*

NATURAL FEATURES

Topography: *Valley.*
Drainage: *Natural.*
Flood conditions: *Yearly.*
Silt deposition: *Very little.*
Type of forest growth: *Scrub, second growth.*

CULTIVATION HISTORY

When cleared and planted? *Heavy trees cut out in 1904–5; never planted.*
Number of replantings: Why?
General condition when in production:
Plowed? When? Grubbed? When?
Years in bananas: Life of farm:
Years in bush or fallow:
Other crops grown:

DISEASE HISTORY

When first noted:
Age of plants when attacked:
Rapidity of spread:
Treatment given:

OTHER DATA

Bananas about 100 meters distant, planted about two years ago and in very good production. About 200 hectares of this land can be irrigated.

	Surface—6"	6"—18"	18"—30"
Physical Examination			
Color	dark brown	brown	brown
Compactness	loose	loose	loose
Friability	light	light	light
Retentive power	88	60	52
Mechanical Examination			
Coarse gravel	0	0	0
Fine gravel	0	0	0
Coarse sand	0	0	0
Fine sand	.1	.1	24.3
Silt	95.3	93.1	72.4
Clay	4.6	6.8	3.3
Chemical Examination			
Organic matter	11.30	7.94	4.87
Total Nitrogen	.01	.20	.06
Potash (K_2O)	.63	.40	.66
Phosphoric acid (P_2O_5)	.16	.23	.18
Lime (CaO)	1.01	2.43	1.85
Magnesia (MgO)	1.60	1.82	2.06
Iron (Fe_2O_3)	11.10	11.77	9.07
Alumina (Al_2O_3)			
Silica, sol. (SiO_2)			
Free Acidity			
Mycological Examination			
Typical Fusaria			
Other Fusaria			

COLOMBIA DIVISION

SERIAL NUMBER *522*

Location: *Paris* Farm, Section *18*. Date: *December, 1916.*

Other distinguishing features: *Abandoned farm.* Collector: *L. W. W.*

NATURAL FEATURES

Topography: *Valley.*
Drainage: *Open ditches.*
Flood conditions: *Once in three or four years.*
Silt deposition: *Slight amount.*
Type of forest growth: *Light.*

CULTIVATION HISTORY

When cleared and planted: *1913.*
Number of replantings: *One.* Why? *Poor result from first.*
General condition when in production: *Bad.*
Plowed? *No.* When? Grubbed? *No.* When?
Years in bananas: *Two.* Life of farm: *Abandoned after two years.*
Years in bush or fallow: *Since March, 1916.*
Other crops grown: *None.*

DISEASE HISTORY

When first noted: *No disease.*
Age of plants when attacked:
Rapidity of spread:
Treatment given:

OTHER DATA

This farm was abandoned completely in March, 1916, because the greater part of the area cultivated was considered worthless for banana production.

	Surface—6"	6"—18"	18"—30"
PHYSICAL EXAMINATION			
Color	light brown	light brown	light brown
Compactness	very hard	very hard	very hard
Friability	stiff	stiff	stiff
Retentive power	72	71	63
MECHANICAL EXAMINATION			
Coarse gravel	0	0	0
Fine gravel	0	0	0
Coarse sand	0	0	0
Fine sand	0	0	0
Silt	94.5	97.6	94.6
Clay	5.5	2.4	5.4
CHEMICAL EXAMINATION			
Organic matter	5.24	9.53	9.04
Total Nitrogen	.23	.09	.01
Potash (K_2O)	.61	.35	.64
Total Nitrogen	.08	.14	.20
Lime (CaO)	1.61	1.82	1.06
Magnesia (MgO)	1.36	.88	1.22
Iron (Fe_2O_3)	10.24	7.38	6.53
Alumina (Al_2O_3)			
Silica, sol. (SiO_2)			
Free Acidity			
MYCOLOGICAL EXAMINATION			
Typical Fusaria			
Other Fusaria			

COLOMBIA DIVISION

SERIAL NUMBER *523*

Location: *Castillo* Farm, Section *7*. Date: *December, 1916.*

Other distinguishing features: Collector: *L. W. W.*

NATURAL FEATURES

Topography: *Valley.*
Drainage: *Open ditches, drainage has been faulty.*
Flood conditions: *Yearly.*
Silt deposition: *About an inch per year.*
Type of forest growth: *Heavy.*

CULTIVATION HISTORY

When cleared and planted: *1909 and replanted in 1910.*
Number of replantings: *One.* Why? *General practice.*
General condition when in production:
Plowed? *No.* When? Grubbed? *No.* When?
Years in bananas: *Six.* Life of farm: *Very good producer.*
Years in bush or fallow: *Never.*
Other crops grown: *None.*

DISEASE HISTORY

When first noted: *A form of banana disease has appeared.*
Age of plants when attacked: *Since first planted.*
Rapidity of spread: *Does not seem to be spreading.*
Treatment given: *Digging out and liming.*

OTHER DATA

	Surface—6"	6"—18"	18"—30"
PHYSICAL EXAMINATION			
Color	dark brown	brown	light brown
Compactness	loose	loose	loose
Friability	light	light	light
Retentive power	61	50	50
MECHANICAL EXAMINATION			
Coarse gravel	0	0	0
Fine gravel	0	0	0
Coarse sand	0	0	0
Fine sand	.9	.4	.8
Silt	97.3	97.6	93.7
Clay	1.8	2.0	5.5
CHEMICAL EXAMINATION			
Organic matter	6.09	2.16	3.14
Total Nitrogen	.19	.12	.08
Potash (K_2O)	.46	.63	1.25
Phosphoric acid (P_2O_5)	.07	.13	.21
Lime (CaO)	1.39	1.29	1.35
Magnesia (MgO)	1.45	.38	1.35
Iron (Fe_2O_3)	10.20	5.10	6.47
Alumina (Al_2O_3)			
Silica, sol. (SiO_2)			
Free Acidity			
MYCOLOGICAL EXAMINATION			
Typical Fusaria			
Other Fusaria	*A type similar to F. radicicola may be the cause of the disease.*		

COLOMBIA DIVISION

SERIAL NUMBER *524*

Location: *Cauca* Farm, Section *2*.
Other distinguishing features:

Date: *December, 1916.*
Collector: *L. W. W.*

NATURAL FEATURES

Topography: *Valley.*
Drainage: *Open ditches.*
Flood conditions: *None.*
Silt deposition: *None.*
Type of forest growth: *Light.*

CULTIVATION HISTORY

When cleared and planted: *1910 and replanted in 1911.*
Number of replantings: *One.* Why? *General practice.*
General condition when in production: *Fair.*
Plowed? *No.* When? Grubbed? *No.* When?
Years in bananas: *Five.* Life of farm: *Production still good.*
Years in bush or fallow: *Never.*
Other crops grown: *None.*

DISEASE HISTORY

When first noted: *No disease.*
Age of plants when attacked:
Rapidity of spread:
Treatment given:

OTHER DATA

	Surface—6″	6″—18″	18″—30″
Physical Examination			
Color	dark brown	light brown	light brown
Compactness	loose	loose	loose
Friability	sandy	sandy	sandy
Retentive power	54	30	38
Mechanical Examination			
Coarse gravel	0	0	0
Fine gravel	0	.9	7.7
Coarse sand	0	15.4	14.7
Fine sand	38.6	62.8	29.1
Silt	58.7	19.9	46.9
Clay	2.7	1.0	1.6
Chemical Examination			
Organic matter	8.02	1.96	2.78
Total Nitrogen	.20	.05	.01
Potash (K_2O)	1.15	.40	.53
Phosphoric acid (P_2O_5)	.19	.08	.12
Lime (CaO)	1.37	.67	1.18
Magnesia (MgO)	.86	.80	.53
Iron (Fe_2O_3)	4.95	3.92	5.98
Alumina (Al_2O_3)			
Silica, sol. (SiO_2)			
Free Acidity			
Mycological Examination			
Typical Fusaria			
Other Fusaria			

COLOMBIA DIVISION

SERIAL NUMBER *525*

Location: *Garapata* Farm, Section *23; Pasture.* Date: *December, 1916.*

Other distinguishing features: *Near Antioquia.* Collector: *L. W. W.*

NATURAL FEATURES

Topography: *Valley.*
Drainage: *Natural.*
Flood conditions: *Rarely covered with water.*
Silt deposition: *Some deposit.*
Type of forest growth: *Heavy timber.*

CULTIVATION HISTORY

When cleared and planted: *Cleared in 1911, Para grass in 1911, no bananas.*
Number of replantings: Why?
General condition when in production:
Plowed? When? Grubbed? When?
Years in bananas: Life of farm:
Years in bush or fallow: *Five years in pasture.*
Other crops grown: *None.*

DISEASE HISTORY

When first noted:
Age of plants when attacked:
Rapidity of spread:
Treatment given:

OTHER DATA

About 100 hectares seem to be very good banana land.

	Surface—6"	6"—18"	18"—30"
PHYSICAL EXAMINATION			
Color	dark brown	light brown	light brown
Compactness	loose	loose	loose
Friability	light	light	light
Retentive power	59	46	45
MECHANICAL EXAMINATION			
Coarse gravel	0	0	0
Fine gravel	0	0	0
Coarse sand	0	0	.1
Fine sand	3.9	.7	8.5
Silt	93.8	97.8	90.2
Clay	2.3	1.5	1.2
CHEMICAL EXAMINATION			
Organic matter	5.12	2.92	3.99
Total Nitrogen	.15	.06	.01
Potash (K_2O)	.64	.98	.36
Phosphoric acid (P_2O_5)	.18	1.78	.06
Lime (CaO)	1.39	1.21	1.55
Magnesia (MgO)	.95	.72	.95
Iron (Fe_2O_3)	6.28	5.85	6.19
Alumina (Al_2O_3)			
Silica, sol. (SiO_2)			
Free Acidity			
MYCOLOGICAL EXAMINATION			
Typical Fusaria			
Other Fusaria			

COLOMBIA DIVISION

SERIAL NUMBER *526*

Location: *Bremen* Farm, Section ; *Near house.* Date: *December, 1916.*

Other distinguishing features: Collector: *L. W. W.*

NATURAL FEATURES

Topography: *Upland.*
Drainage: *Open ditches.*
Flood conditions: *None.*
Silt deposition: *None.*
Type of forest growth: *Light.*

CULTIVATION HISTORY

When cleared and planted: *1908–9.*
Number of replantings: *Two.* Why? *Poor condition.*
General condition when in production: *Bad.*
Plowed? *No.* When? Grubbed? *No.* When?
Years in bananas: *Six.* Life of farm: *Abandoned March, 1916.*
Years in bush or fallow: *Six months.*
Other crops grown: *None.*

DISEASE HISTORY

When first noted: *No disease.*
Age of plants when attacked:
Rapidity of spread:
Treatment given:

OTHER DATA

	Surface—6"	6"—18"	18"—30"
Physical Examination			
Color	dark brown	light brown	light brown
Compactness	coarse	coarse	coarse
Friability	sandy	sandy	sandy
Retentive power	44	41	36
Mechanical Examination			
Coarse gravel	0	0	0
Fine gravel	4.4	3.6	0
Coarse sand	3.7	2.3	0
Fine sand	22.5	19.4	6.3
Silt	67.5	73.3	91.7
Clay	1.9	1.4	2.0
Chemical Examination			
Organic matter	3.84	3.08	3.18
Total Nitrogen	.14	.09	.06
Potash (K_2O)	.70	1.14	.50
Phosphoric acid (P_2O_5)	.13	0	.11
Lime (CaO)	1.77	1.50	1.47
Magnesia (MgO)	.95	.53	1.00
Iron (Fe_2O_3)	5.31	4.66	5.41
Alumina (Al_2O_3)			
Silica, sol. (SiO_2)			
Free Acidity			
Mycological Examination			
Typical Fusaria			
Other Fusaria			

COLOMBIA DIVISION

SERIAL NUMBER *527*

Location: *Bolivar* Farm, Section *4*. Date: *December, 1916.*

Other distinguishing features: *Abandoned section.* Collector: *L. W. W.*

NATURAL FEATURES

Topography: *Valley.*
Drainage: *Open ditches.*
Flood conditions: *None.*
Silt deposition: *None.*
Type of forest growth: *Medium.*

CULTIVATION HISTORY

When cleared and planted: *1911–12.*
Number of replantings: *None.* Why? *Abandoned as not worth while.*
General condition when in production: *Poor.*
Plowed? *No.* When? Grubbed? *No.* When?
Years in bananas: *Four.* Life of farm: *Production low and abandoned.*
Years in bush or fallow: *Never.*
Other crops grown: *None.*

DISEASE HISTORY

When first noted: *No disease.*
Age of plants when attacked:
Rapidity of spread:
Treatment given:

OTHER DATA

	Surface—6"	6"—18"	18"—30"
PHYSICAL EXAMINATION			
Color	brown	light brown	brown
Compactness	hard	hard	hard
Friability	refractory	refractory	refractory
Retentive power	53	45	44
MECHANICAL EXAMINATION			
Coarse gravel	0	0	0
Fine gravel	0	0	0
Coarse sand	0	0	0
Fine sand	.9	0	0
Silt	96.9	97.5	97.5
Clay	2.2	2.5	2.5
CHEMICAL EXAMINATION			
Organic matter	6.89	6.37	5.83
Total Nitrogen	.15	.06	.07
Potash (K_2O)	.44	.14	.12
Phosphoric acid (P_2O_5)	.13	.08	.13
Lime (CaO)	1.07	1.34	1.03
Magnesia (MgO)	.69	.75	.56
Iron (Fe_2O_3)	4.77	6.53	5.58
Alumina (Al_2O_3)			
Silica, sol. (SiO_2)			
Free Acidity			
MYCOLOGICAL EXAMINATION			
Typical Fusaria			
Other Fusaria			

COLOMBIA DIVISION

SERIAL NUMBER *528*

Location: *Santana land* Farm, Section *; At junction of Camino del Bango with Camino del Media Luna.*

Date: *December, 1916.*
Collector: *L. W. W.*

Other distinguishing features:

NATURAL FEATURES

Topography: *Valley.*
Drainage: *Natural.*
Flood conditions: *None.*
Silt deposition: *None.*
Type of forest growth: *Second growth.*

CULTIVATION HISTORY

When cleared and planted: *Cleared in 1914, never planted.*
Number of replantings: Why?
General condition when in production:
Plowed? When? Grubbed? When?
Years in bananas: Life of farm:
Years in bush or fallow:
Other crops grown:

DISEASE HISTORY

When first noted:
Age of plants when attacked:
Rapidity of spread:
Treatment given:

OTHER DATA

This tract comprises about 7,993 hectares of land, about 1,000 hectares of which seem to be fairly suitable for bananas.

	Surface—6″	6″—18″	18″—30″
Physical Examination			
Color	brown	light brown	light brown
Compactness	loose	loose	loose
Friability	light	light	light
Retentive power	46	45	43
Mechanical Examination			
Coarse gravel	0	0	0
Fine gravel	0	0	7.2
Coarse sand	0	0	20.5
Fine sand	30.0	1.5	36.2
Silt	68.9	96.8	34.3
Clay	1.1	1.7	1.8
Chemical Examination			
Organic matter	5.97	5.08	4.42
Total Nitrogen	.17	.03	.07
Potash (K_2O)	.37	.37	.33
Phosphoric acid (P_2O_5)	.21	.51	.11
Lime (CaO)	1.07	.90	1.65
Magnesia (MgO)	.59	.54	.72
Iron (Fe_2O_3)	4.05	5.85	5.77
Alumina (Al_2O_3)			
Silica, sol. (SiO_2)			
Free Acidity			
Mycological Examination			
Typical Fusaria			
Other Fusaria			

COLOMBIA DIVISION

SERIAL NUMBER *529*

Location: *Santana land* Farm, Section *; About 500 meters south of central corral and Camino del Media Luna.*

Date: *December, 1916.*
Collector: *L. W. W.*

Other distinguishing features:

NATURAL FEATURES
Topography: *Valley.*
Drainage: *Natural.*
Flood conditions: *Once in four or five years.*
Silt deposition: *About one to three inches with floods.*
Type of forest growth: *Heavy virgin.*

CULTIVATION HISTORY
When cleared and planted: *Underbrush in 1914, never planted.*
Number of replantings: Why?
General condition when in production:
Plowed? When? Grubbed? When?
Years in bananas: Life of farm:
Years in bush or fallow:
Other crops grown:

DISEASE HISTORY
When first noted:
Age of plants when attacked:
Rapidity of spread:
Treatment given:

OTHER DATA
See note under 528.

	Surface—6"	6"—18"	18"—30"
Physical Examination			
Color	brown	brown	light brown
Compactness	loose	loose	loose
Friability	light	light	light
Retentive power	55	51	33
Mechanical Examination			
Coarse gravel	0	0	0
Fine gravel	0	0	.5
Coarse sand	.5	0	0
Fine sand	30.0	2.4	13.6
Silt	68.0	96.1	84.6
Clay	1.5	1.5	1.3
Chemical Examination			
Organic matter	6.29	4.37	3.06
Total Nitrogen	.17	.11	.06
Potash (K_2O)	.40	.18	.58
Phosphoric acid (P_2O_5)	.11	1.56	.16
Lime (CaO)	1.79	1.02	.83
Magnesia (MgO)	.62	.72	.87
Iron (Fe_2O_3)	4.36	6.03	4.50
Alumina (Al_2O_3)			
Silica, sol. (SiO_2)			
Free Acidity			
Mycological Examination			
Typical Fusaria			
Other Fusaria			

COLOMBIA DIVISION

SERIAL NUMBER *530*

Location: *Davila lands* Farm, Section *; Southeast corner of lot near Turcurinca River, woodland.*

Date: *December, 1916.*
Collector: *L. W. W.*

Other distinguishing features:

NATURAL FEATURES
- Topography: *Valley.*
- Drainage: *Natural.*
- Flood conditions: *Extreme high water, once in four or five years.*
- Silt deposition: *About an inch at such times.*
- Type of forest growth: *Medium.*

CULTIVATION HISTORY
- When cleared and planted: *Felled 1911, no planting.*
- Number of replantings: Why?
- General condition when in production:
- Plowed? When? Grubbed? When?
- Years in bananas: Life of farm:
- Years in bush or fallow:
- Other crops grown:

DISEASE HISTORY
- When first noted:
- Age of plants when attacked:
- Rapidity of spread:
- Treatment given:

OTHER DATA

Woodland extension of Turcurinca cultivations; part near Turcurinca River appears to be suitable for bananas, about 300 hectares.

	Surface—6″	6″—18″	18″—30″
PHYSICAL EXAMINATION			
Color	brown	light brown	yellow
Compactness	loose	hard	hard
Friability	light	refractory	refractory
Retentive power	54	40	27
MECHANICAL EXAMINATION			
Coarse gravel	0	0	0
Fine gravel	0	0	29.1
Coarse sand	.8	9.6	49.0
Fine sand	24.9	26.4	17.5
Silt	70.7	62.8	4.0
Clay	3.6	1.2	.4
CHEMICAL EXAMINATION			
Organic matter	7.69	3.84	.88
Total Nitrogen	.26	.01	.03
Potash (K_2O)	.40	.45	.33
Phosphoric acid (P_2O_5)	.22	.20	.18
Lime (CaO)	.98	.82	1.65
Magnesia (MgO)	.90	.49	.72
Iron (Fe_2O_3)	5.24	4.70	5.77
Alumina (Al_2O_3)			
Silica, sol. (SiO_2)			
Free Acidity			
MYCOLOGICAL EXAMINATION			
Typical Fusaria			
Other Fusaria			

COLOMBIA DIVISION

SERIAL NUMBER *531*

Location: *Davila lands* Farm, Section *; Woodland.* Date: *December, 1916.*

Other distinguishing features: *About 2 kilometers north of 530.* Collector: *L. W. W.*

NATURAL FEATURES

Topography: *Valley.*
Drainage: *Natural.*
Flood conditions: *Yearly.*
Silt deposition: *None.*
Type of forest growth: *Light.*

CULTIVATION HISTORY

When cleared and planted: *Not cleared or planted.*
Number of replantings: Why?
General condition when in production:
Plowed? When? Grubbed? When?
Years in bananas: Life of farm:
Years in bush or fallow:
Other crops grown:

DISEASE HISTORY

When first noted:
Age of plants when attacked:
Rapidity of spread:
Treatment given:

OTHER DATA

	Surface—6″	6″—18″	18″—30″
Physical Examination			
Color	brown	light brown	light brown
Compactness	hard	hard	hard
Friability	refractory	refractory	refractory
Retentive power	60	43	67
Mechanical Examination			
Coarse gravel	0	0	0
Fine gravel	1.6	1.4	.3
Coarse sand	4.1	10.5	.8
Fine sand	24.7	38.0	22.3
Silt	67.8	47.5	70.3
Clay	1.8	2.6	6.3
Chemical Examination			
Organic matter	7.18	5.18	8.21
Total Nitrogen	.23	.08	.09
Potash (K_2O)	.18	.48	.80
Phosphoric acid (P_2O_5)	.12	.08	.12
Lime (CaO)	1.17	.75	1.70
Magnesia (MgO)	1.01	.86	.96
Iron (Fe_2O_3)	5.09	6.25	7.20
Alumina (Al_2O_3)			
Silica, sol. (SiO_2)			
Free Acidity			
Mycological Examination			
Typical Fusaria			
Other Fusaria			

Average Analyses—Colombia

Sample	Fine Gravel	Coarse Sand	Fine Sand	Silt	Clay	K_2O	CaO	MgO	Fe_2O_3	P_2O_5	Vol. Mat.	Tot. N	RP
Helena	0	0	0.5	97.0	2.5	.29	2.28	1.45	7.64	.26	3.93	.10	49
San Antonio	0	0.4	14.4	83.9	1.3	.84	2.09	1.29	6.88	.24	2.72	.05	39
Magola	0	0	1.4	97.3	1.3	.59	2.91	1.17	6.86	.22	3.30	.05	36
Ceibales	0	0	0.8	98.3	0.9	.48	2.63	.96	6.38	.21	3.86	.08	48
Olivo	0	0	6.5	91.3	2.2	.40	2.14	1.95	6.04	.15	3.22	.07	41
Esperanza	0	0	1.4	93.4	5.2	.46	2.32	1.21	7.27	.15	2.63	.03	38
Lucia	0	0	0.3	97.0	2.7	.49	1.99	1.69	7.49	.28	4.78	.07	44
Elias	0.5	3.1	25.6	69.1	1.7	.32	1.92	1.51	6.15	.23	3.39	.11	36
Elias	0.1	3.0	19.5	75.0	2.4	.36	1.95	1.59	7.04	.16	5.16	.05	46
Canobobal	0	0	0	96.2	3.8	.34	2.60	1.58	8.87	.04	5.54	.05	57
Canobobal	0.2	0.3	1.1	94.4	4.0	.17	2.79	2.27	10.49	.24	5.47	.13	56
Macondo 20	0	0	8.3	89.0	2.7	.71	2.08	.83	8.57	.19	5.90	.03	53
Latal	0	0	1.5	95.6	2.9	.29	3.01	1.72	6.56	.11	5.46	.15	61
Macondo 13	0	0	0.7	95.9	3.4	.16	1.87	1.30	7.12	.17	6.40	.15	52
Florida	0	0.1	9.4	88.5	2.0	.38	3.41	1.73	7.06	.23	3.39	.08	37
Esperanza	0	0	0.1	93.5	6.4	.23	3.07	1.77	8.12	.15	8.06	.09	67
Latal	0.9	0.9	12.9	83.4	1.9	.17	2.30	1.66	5.56	.24	4.06	.11	51
Latal	1.4	6.5	20.2	69.9	2.0	.39	9.67	1.73	6.04	.22	4.06	.07	43
Catalina	0	0	2.4	95.5	2.1	.62	1.97	1.82	7.75	.21	5.29	.01	61
Miranda	2.8	6.6	20.9	68.6	1.1	1.04	2.31	1.68	7.99	.25	2.69	.08	45
Miranda	0	0	9.8	85.3	4.9	.55	1.91	1.87	10.55	.19	7.38	.11	62
Paris	0	0	0	95.8	4.2	.52	1.47	1.11	7.61	.15	8.48	.09	68
Castillo	0	0	0.7	95.9	3.4	.84	1.33	.98	6.67	.15	3.34	.12	52
Cauca	3.4	12.0	44.5	38.5	1.6	.60	1.01	.70	4.95	.12	3.50	.06	38

Garapata	0	0	4.4	94.1	1.5	.66	1.38	.86	6.07	.77	3.79	.06	48
Bremen	2.3	1.7	14.7	79.5	1.8	.80	1.54	.80	5.09	.07	3.27	.09	40
Bolivar	0	0	0.2	97.4	2.4	.19	1.16	.66	5.80	.11	6.26	.08	46
Santana	2.9	8.2	21.1	66.2	1.6	.35	1.23	.62	5.46	.29	4.99	.07	44
Santana	0.2	.01	12.4	85.9	1.4	.38	1.10	.76	5.08	.71	4.23	.10	45
Davila	11.6	23.6	22.6	40.9	1.3	.39	1.18	.66	5.23	.19	3.43	.07	38
Davila	1.0	5.3	29.1	60.7	3.9	.55	1.21	.93	6.40	.10	6.79	.11	56
Whole Division	1.0	2.5	10.3	83.7	2.5	.47	2.19	1.28	6.85	.22	4.76	.08	48

AVERAGE OF RESULTS BY DISTRICTS

Rio Frio	0.1	0.6	6.5	90.3	2.5	.43	2.33	1.52	7.37	.19	4.00	.07	45
Sevilla	0.5	1.3	7.8	87.4	3.0	.46	3.01	1.57	7.54	.19	5.56	.09	55
Aracataca	2.4	5.7	16.6	73.2	2.1	.53	1.24	.77	5.64	.28	4.73	.08	45
Silt Deposits	1.1	2.8	10.4	82.5	3.2	.45	1.79	1.26	7.12	.26	5.29	.09	52
No Silt Deposits	0.9	2.2	10.2	84.9	1.8	.49	2.59	1.30	6.58	.18	4.23	.07	44

Ratio of Lime to Magnesia

1–1 to 5–1 regarded as normal

501. Helena
2.0–1
1.0–1
1.0–1

502. San Antonio
1.0–1
2.0–1
3.0–1

503. Magola
6.0–1
2.0–1
2.0–1

504. Ceibales
2.0–1
3.0–1
2.0–1

505. Olivo
1.0–1
1.0–1
2.0–1

506. Esperanza
3.0–1
3.0–1
2.0–1

507. Lucia
2.0–1
3.0–1
1.0–1

508. Elias
2.0–1
1.0–1
1.0–1

509. Elias
2.0–1
1.0–1
2.0–1

510. Canobobal
1.0–1
2.0–1
2.0–1

511. Canobobal
1.0–1
1.0–1
1.0–1

512. Macondo
3.0–1
2.0–1
2.0–1

513. Latal
1.0–1
1.0–1
3.0–1

514. Macondo
4.0–1
2.0–1
2.0–1

515. Florida
3.0–1
1.5–1
2.0–1

516. Esperanza
2.0–1
2.0–1
1.5–1

517. Latal
1.5–1
1.0–1
1.0–1

518. Latal
9.0–1
1.0–1
1.5–1

519. Catalina
8.0–1
.1–1
1.3–1

520. Miranda
2.0–1
1.5–1
1.0–1

521. Miranda
.6–1
1.3–1
.9–1

522. Paris
1.0–1
2.0–1
.9–1

523. Castillo
.9–1
4.0–1
1.0–1

524. Cauca
2.0–1
.7–1
2.0–1

525. Garapata
1.4–1
1.5–1
1.5–1

526. Bremen
2.0–1
3.0–1
1.4–1

527. Bolivar
1.5–1
1.5–1
2.0–1

528. Santana
2.0–1
2.0–1
2.0–1

529. Santana
3.0–1
1.2–1
.9–1

530. Davila
1.0–1
2.0–1
2.0–1

531. Davila
1.0–1
.8–1
2.0–1

Ratio of Organic Matter to Nitrogen

30–1 to 40–1 regarded as normal

501. Helena
30–1
34–1
54–1

502. San Antonio
26–1
307–1
46–1

503. Magola
309–1
45–1
35–1

504. Ceibales
24–1
314–1
222–1

505. Olivo
25–1
48–1
199–1

506. Esperanza
538–1
243–1
30–1

507. Lucia
873–1
40–1
50–1

508. Elias
22–1
30–1
48–1

509. Elias
140–1
542–1
38–1

510. Canobobal
864–1
492–1
46–1

511. Canobobal
24–1
37–1
54–1

512. Macondo
36–1
27–1
55–1

513. Latal
36–1
51–1
72–1

514. Macondo
672–1
600–1
88–1

515. Florida
3–1
60–1
51–1

516. Esperanza
1010–1
53–1
94–1

517. Latal
30–1
34–1
68–1

518. Latal
35–1
190–1
59–1

519. Catalina
361–1
386–1
757–1

520. Miranda
30–1
31–1
36–1

521. Miranda
1130–1
37–1
81–1

522. Paris
23–1
106–1
904–1

523. Castillo
32–1
18–1
39–1

524. Cauca
40–1
39–1
278–1

525. Garapata
34–1
48–1
399–1

526. Bremen
27–1
34–1
53–1

527. Bolivar
45–1
106–1
86–1

528. Santana
30–1
169–1
63–1

529. Santana
33–1
38–1
51–1

530. Davila
33–1
384–1
29–1

531. Davila
31–1
64–1
91–1

Examination of Individual Farms

Helena. A soil of fair depth, very low in organic matter, but otherwise of good character.

San Antonio. A rather thin soil which has given only fair production. In spite of being very high in potash and lime, it is poor because of the extremely low organic matter and nitrogen.

Magola. Fair depth, high in potash, but very low in organic matter and nitrogen.

Ceibales. A farm with a good record, but thin and extremely low below the surface layer in organic matter and nitrogen, fairly high in lime.

Olivo. An alkaline or salty farm which is very low in organic matter and nitrogen and on the whole a poor soil.

Esperanza. A soil deficient in organic matter, nitrogen and phosphoric acid, iron high in deeper layers.

Lucia. An old farm with a fundamentally good soil, high in potash, but low in organic matter and nitrogen; rather high in iron.

Elias. A wild land with deficient organic matter and nitrogen, rather high in sand and low in silt and clay.

Elias. A thin soil with a refractory subsoil, very low in nitrogen.

Canobobal. Low nitrogen and phosphoric acid make this area rather unpromising.

Canobobal. A fairly good soil with a high percentage of silt, but high in iron.

Latal. A good soil of fair depth, low in phosphoric acid.

Macondo 13. A soil of good structure and well-balanced analysis.

Macondo 20. A hard, stiff soil which, in spite of high potash and fair phosphoric acid and lime, is

objectionable because of physical qualities: deficient in nitrogen and high in iron.

Florida. Physical properties undesirable, low in nitrogen; the potash, lime and phosphoric acid figures are satisfactory, but do not overbalance the bad physical qualities.

Latal. A soil of fair depth which should be good for a few years.

Latal. Surface conditions good, but tapers off to a rather poor subsoil.

Catalina. A worn-out soil of rather poor quality, high in iron.

Miranda. A soil with very low water-retaining power and very deficient in organic matter and nitrogen. Potash, phosphoric acid and lime are satisfactory.

Miranda. This area has good qualities and fair depth except for the deficient nitrogen; iron, however, is high.

Paris. Regarded as worthless for banana cultivation, probably due to hardness, which prevents proper rootage, and deficiency in nitrogen and phosphoric acid. The iron is also much higher than desirable.

Castillo. This is a good soil, but rather thin and deficient in organic matter and phosphoric acid. A peculiar disease has developed on this area.

Cauca. A soil of low analysis, but with no objectionable features and fairly good depth.

Garapata. A soil of fair depth, high in potash and phosphoric acid.

Bremen. A soil of extremely low water-retaining power, also low in organic matter, nitrogen and phosphoric acid, so that it must be regarded as very poor.

Bolivar. A very hard, refractory soil, low in nitrogen and phosphoric acid. Not likely to be productive.

Santana. A soil with low water-retaining power and very low in nitrogen. The surface analysis is good.

Santana. An area with low water-retaining power and deficient in nitrogen.

Davila. A soil which shows a good surface indication, but the subsoil is hard and extremely deficient in plant foods.

Davila. A soil with good analysis, but so hard and refractory that it cannot be regarded as satisfactory.

Tabular View of Soil Conditions

Explanation of Abbreviations

Potash— h = greater than .30%
l = less than .15%
Lime— h = greater than 2%
l = less than 1%
Organic Matter—h = greater than 15%
l = less than 9%

Nitrogen— h = greater than .30%
l = less than .15%
Phosphoric Acid—h = greater than .30%
l = less than .15%

h = high m = medium r = rapid * = hard, refractory soil
l = low v = very s = slow

Farm	*History*	*Depth*	*Potash*	*Lime*	*Organic Matter*	*Nitrogen*	*Phosphoric Acid*	*Disease Spread*
Helena	good	fair	m-h	h	vl	l	m	
San Antonio	fair	v thin	vh	h	vl	vl	m	
Magola	good	fair	h	h	vl	vl	m	
Ceibales	good	thin	h	h	vl	l	m	
Olivo	fair	thin	h	h	vl	vl	m-l	
Esperanza	good	v thin	h	h	vl	vl	m-l	
Lucia	good	fair	h	h	l	l	m-h	
Elias	–	good	m	m	l	l	m	
Elias	–	good	m	m	l	vl	m	
Canobobal	–	good	m	h	l	vl	l	
Canobobal	–	good	m-l	h	l	l	m	high iron
Latal	good	fair	m	h	l	m	l	high iron
Macondo 13	good	good	ml	m	l	m	m	
*Macondo 20	bad	good	h	h	lm	vl	m	high iron

Florida	fair	good	m	h	vl	l	m	high iron
*Esperanza	bad	fair	m	h	l	l	ml	high iron
Latal	–	fair	ml	h	m	l	m	
Latal	–	fair	m	vh	l	l	m	
*Catalina	good–poor	fair	h	mh	l	vl	m	high iron
Miranda	–	thin	vh	h	vl	l	m	high iron
Miranda	–	good	h	m	m	l	m	v high iron
Paris	bad	fair	h	m	m	l	ml	
Castillo	good	fair	vh	m	vl	ml	ml	
Cauca	fair	thin	h	ml	vl	vl	l	
Garapata	–	fair	h	m	vl	l	h	
Bremen	poor	v thin	vh	m	vl	l	vl	
*Bolivar	poor	good	ml	ml	lm	l	l	
Santana	–	fair	h	m	l	l	m	
Santana	–	v thin	h	ml	l	l	h	
*Davila	–	v thin	h	m	vl	l	m	
*Davila	–	good	h	m	lm	l	l	

XI. Special Studies from all the Analyses

A survey of the analyses of the six divisions offers data for a number of special studies upon points which are of interest from the standpoint of general agriculture. I shall first of all make some comparisons on the woodland or virgin soils which have been collected.

Examination of Virgin or Woodland Soils

In four of the six divisions a number of woodland soils have been collected and examined. These examinations have had a triple purpose: (1) as a means of learning something of the original conditions of untouched tropical soils; (2) to give a means of comparing new lands with farms of the same general region and geologic and climatic conditions, and (3) to provide some data which possibly might be useful in directing further extensions of agricultural operations.

No forest or virgin soils were collected in the Jamaica and Costa Rica Divisions, but the conditions in the latter are so similar to those in the Panama Division that the observations and comparisons may probably be made as applicable to both without serious error or unfairness.

In the Panama Division ten samples were collected in the Talamanca valley. While probably not as fertile as the larger valley of the Sixaola they perhaps represent conditions fairly well for the plains. In addition to Talamanca samples, two other samples have been included, one from Nievecito and one from Riverside, taken from newly cleared and planted areas of these farms.

The detailed analyses of all these samples (Nos. 115, 117, 125–133), are given in the records of data

of this Division, but the average of all is here given as representative analysis for virgin or uncultivated soils in this region.

Mechanical Analysis.

Fine gravel	*Coarse sand*	*Fine sand*	*Silt*	*Clay*
1.2	14.9	31.4	48.5	4.

Chemical Analysis.

Potash	*Lime*	*Magnesia*	*Iron*	*Phosphoric acid*	*Organic matter*	*Nitrogen*
.34	1.73	1.01	9.24	.37	7.17	.13

These figures vary but little from the average analyses for the whole Division.

In the Honduras Division eleven woodland soils were collected for examination, viz., Uluasito, Zuniga, four in San Alejos, Hill Line, four in the Bogran Estate. Their analyses are given in detail under samples numbered 309, 312, 316, 319, 326 and 329-332. The Hill Line sample is so different from the others and so different from the Division as a whole in its mechanical analysis that it is hardly fair to include it in the average. Leaving this one sample out of account we have for average analyses the following:

Mechanical Analysis.

Fine gravel	*Coarse sand*	*Fine sand*	*Silt*	*Clay*
1.85	3.12	11.5	8.07	2.6

Chemical Analysis.

Potash	*Lime*	*Magnesia*	*Iron*	*Phosphoric acid*	*Organic matter*	*Nitrogen*
.47	1.54	1.03	5.79	.18	5.62	.10

As a matter of fact the individual samples used for this average vary considerably among themselves, although the average is not greatly different from the analysis for the Division as a whole.

In the Guatemala Division but four samples of

woodland or virgin soils have been examined, and these are Comanche, Sacramento, Central Lands and Plietas. For detailed analyses see samples numbered 231, 232, 233 and 234. While showing considerable variation, their average analyses are interesting and show a fairly close similarity to the division averages.

Mechanical Analysis.

Fine sand	*Silt*	*Clay*
3.6	9.51	1.3

Chemical Analysis.

Potash	*Lime*	*Magnesia*	*Iron*	*Phosphoric acid*	*Organic matter*	*Nitrogen*
.46	.84	.97	5.28	.14	4.77	.12

In the Colombia Division eleven samples have been examined as follows: Elias tract, 508, 509; Latal, 517, 518; Miranda, 520, 521; Garapata, 525; Santana, 528, 529; Davila, 530, 531. Their analyses show considerable variation. The average analyses for all are here given.

Mechanical Analysis.

Fine gravel	*Coarse sand*	*Fine sand*	*Silt*	*Clay*
1.9	5.2	18.0	71.7	2.2

Chemical Analysis.

Potash	*Lime*	*Magnesia*	*Iron*	*Phosphoric acid*	*Organic matter*	*Nitrogen*
.47	2.34	1.26	6.51	.30	4.54	.09

Taking the average of all these woodland and virgin soils we find that the chemical analysis shows the following results:

Potash	*Lime*	*Magnesia*	*Iron*	*Phosphoric acid*	*Organic matter*	*Nitrogen*
.43	1.50	1.04	6.70	.25	5.54	.11

These figures vary from what has been given as a highly satisfactory analysis for tropical agricultural soils chiefly in the much lower organic matter

and nitrogen, and these are just the ingredients which it should be possible to increase or modify by cultivation. In fact the most striking feature brought out in the chemical examination of these forest soils is the lowness of the organic matter and nitrogen, although they do not fall below the figures found in many of the cultivated farms. This at once brings up the question as to whether in tropical soils as a whole there take place the bacteriological changes which are responsible for the transformations and fixation of nitrogen in anything like the intensity found in the temperate zones. On this subject extensive studies of possibly enormous value could be made with advantage.

Effect of Flooding and Silt Deposit

Considerable difference of opinion has been expressed as to the beneficial or injurious results of flooding and silt deposition. In order to secure some data on this point a comparison of the silt history with general agricultural history and length of times areas studied have been in production has been made.

At the outset it may be reiterated that the effect of flooding depends on the duration of the inundation, the quickness of run-off and the rate of flow of the water. The character of deposited material also depends on these factors, but especially on the one last named. In heavy flooding with swift current the effect may be to tear away the surface layers containing most of the organic matter and lightening material, thus denuding the soil of its most valuable part. An instance of this sort occurred in Chirripo Farm in Costa Rica in 1908, thereby greatly impoverishing that farm's soil. Another feature of flooding which may work mischief is that in case any farm is suffering from infection

of any kind the general inundation tends to scatter the infected materials in whatever direction the temporary currents and eddies happen to be moving. No doubt this has taken place in several of the big valleys where flooding is frequent or where especially severe flooding has taken place from time to time.

On the other hand, there is evidence that the yearly or occasional silt deposition has had a most favorable influence on the life and productivity of many farms subject to it, as thereby a new supply of organic and inorganic material in finely divided condition is brought to the land and settles as a fine layer as the water subsides. If such material contains organic matter and is not too heavily saturated with clay or other materials which pack in solid impervious layers so that soil cannot become properly aërated, the result should be advantageous.

Obviously much depends on the character and source of the material carried by the water, so that it is difficult to predict absolutely what the effect of flooding and deposition will be in all cases.

It may be of interest, however, to observe what has actually happened in the past, and in order to make this observation convenient, the tables below have been prepared. The farms which have received more or less heavy silt deposits have been listed by Divisions, and for purposes of correlation the length of time the farm has been in production, the amount of the deposit and its frequency of occurrence and some of the general character of the soil as shown by the physical and chemical studies have been tabulated together. It cannot be assumed that all these characters are the result of siltage, but the comparisons are perhaps not devoid of interest or of value.

Effect of Silt Deposition

COSTA RICA DIVISION

Farm	Years in Bananas	Amount of Deposit	Frequency	Other Characteristics Depth	History
La Amelia	11	6–8″	yearly	good	good
Luisa East	7	4–6″	yearly	good	good
Carmen	5	6–18″	yearly	good	good
Philadelphia North	11	light	in 3 or 4 yrs.	fair	poor
Bananito South	7	heavy	2–3 times yr.	good	good
San Clemente	3	light	yearly	fair	good
Pandora	2	light	yearly	v good	good
Fortuna	3	heavy	2–3 times yr.	good	excel.
Aurora	3	heavy	2–3 times yr.	thin	good
Indiana III	10	heavy	5–6 times yr.	good	excel.
Barmouth West	20	heavy	3–4 times yr.	good	fair
Zent	15	light	in 2 or 3 yrs.	fair	fair
Chirripo	10	light	in 2 or 3 yrs.	thin	good
Alaska	15	heavy	3–4 times yr.	good	good
Blanco	10	heavy	3–4 times yr.	fair	fair
Livingston	16	heavy	2–3 times yr.	thin	good
Bananito North	10	6–8″	2–3 times yr.	good	good
Bearsem West	6	slight	yearly	good	good

PANAMA DIVISION

Chase	5	1–6″	yearly	v	good	fair
Chase	5	1–6″	yearly		good	fair
Paraiso	5	several in.	every few yrs.		good	excel.
La Celia	12	several in.	every few yrs.		good	excel.
Isla Grande	12	1–12″	every 2 yrs.		good	good
La Celia	12	several in.	every few yrs.		thin	excel.
Costa Rica	12	1″+	yearly		good	fair
Jose	9	1″+	frequent		good	good
Drury	8	1″+	frequent		good	good–bad
Margarita	7	1–12″	every 2 yrs.		good	excel.
Margarita	7	1–12″	every 2 yrs.		good	excel.
Catarina	7	1–12″	every 2 yrs.		good	excel.
Nievecito	0				good	
Riverside	12	1″+	2–3 years		good	excel.
Barranco	16	1″+	every 2 yrs.		good	excel.
Elena	10	heavy	yearly		good	good–bad
Senosri	4	heavy	yearly		good	fair
Sibubi	4	1″+	yearly		fair	poor
Dos Canos	6	1–12″	every 2 yrs.		good	good
Favorita	12	1″+	yearly		good	excel.
Olivia	5	1–12″	every 2 yrs.		good	good
Changuinola 8	6	crossed	yearly		good	good
Changuinola 8	12	rarely			good	good

GUATEMALA DIVISION

Farm	Years in Bananas	Amount of Deposit	Frequency	Other Characteristics: Depth	Other Characteristics: History
Cayuga Bend	9	2–4″	yearly	good	excel.
Navajo	9	several in.	yearly	good	excel.
Quirigua	6	6″	yearly	good	excel.
Aztec	6	6″	yearly	good	excel.
Oneida	6, sec. 40	several in.	yearly	good	excel.
Sioux		3–4″	yearly	good	
Comanche		4–6″	yearly	fair	
Apache	2	4–6″	3–4 times yr.	fair	

HONDURAS DIVISION

Dakota	3	heavy	frequent	good	good
Ceibita	4	light	yearly	good	good
Uluasito	3	light	yearly	thin	good
Uluasito	woodland	light	yearly	good	
Zuinga	woodland	moderate	yearly	fair	
Jilamo	1	light	yearly	good	good
Las Palmas	4	heavy	seldom	good	good
San Alejos		1″	yearly	fair	
San Alejos		1″	yearly	good	
San Alejos		1″	yearly	fair	
San Alejos		1″	yearly	v. thin	
Esperanza	12	1″	yearly	good	good–bad

Agua Blanca	6	1″	yearly	good	good
Uluita	9	1″	yearly	good	good
Fortuna	16	½″	yearly	thin	good
Melchers	20	6″	twice a yr.	good	good
Dora	20	6″	twice a yr.	good	good
Bogran Estate		6″	yearly	fair	
Bogran Estate		6″	yearly	good	
Bogran Estate		1″	yearly	good	
Bogran Estate		1″	yearly	thin	
Sulu Pepee	15	several in.	twice a yr.	good	good
Garrisons	12	6″	twice a yr.	good	good
Pica Maya	15	6″	twice a yr.	good	good

JAMAICA DIVISION

Fellowship	20+	slight	seldom	fair	
Golden Grove		2″	yearly	deep	good

COLOMBIA DIVISION

Helena	10	2–3″	yearly	fair	good
Esperanza	4	slight	yearly	thin	good
Paris	2	1″	3–4 yrs.	fair	bad
Castillo	6	1″	yearly	fair	good

The Effect of Topography and Drainage

Numerous observations in the different divisions have led to the belief that topography and drainage are of importance in the cultivation of bananas. In those divisions where the Panama Disease and other banana diseases have been found, drainage has been especially an object of attention, as it has been felt that by this means the spread of the disease might be prevented.

With the examination of such a large number of specimens from different divisions there has arisen the opportunity to study the matter somewhat carefully from a comparative standpoint, eliminating all local or purely temporary factors in the situation. The fact is that the banana lands of the Caribbean Sea region are so fertile and in general so easily cultivated that no special pains have had to be taken to secure good agricultural return. With the advent of diseases of new and unknown character such as are likely to invade new territory, the question of topography and drainage has taken a somewhat different phase. Drainage has therefore been considered with reference to the probable relation to the spread of disease rather than to the well-being, vigor and fruitfulness of the plants.

A survey of the agricultural histories and recorded data on the source and character of the samples has brought out some very interesting and significant facts. The farms made up of bottom or valley lands with light, loose soils have almost invariably had favorable agricultural histories and proved satisfactory over a series of years, and sometimes a long series. On the other hand, the soils which have had bad records are in general those where the physical characters rather than the

chemical were the dominating factors. In the following tables, it will be noted, the majority of farms having poor records or which have been productive for but very few years are those with poor drainage (aside from run-off of casual water) and hard, stiff or refractory soil.

In the following table I have presented by divisions a record of the topography, drainage and physical condition of the soil as to hardness and a description of the agricultural history under the term "record." It is perhaps worth while to point out under the term "drainage" that while the run-off may be satisfactory, the retentive power of the soil for water may be such as to hold back an excess of moisture and produce a condition which may be characterized as *water-logging*. On the other hand, an extremely porous soil with very low retentive power may dry out so quickly that the plants actually suffer from moisture deficiency. This, however, happens only rarely, except in those areas where there is a distinct dry season, and would naturally be most marked in Colombia and a part of Jamaica. It will be noted that most of the hilltop and hillside soils show physical conditions which may explain their poor records, although in a few instances hill soils with a light, loose structure have given excellent results.

COSTA RICA DIVISION

No.	*Topography*	*Drainage*	*Physical Condition*	*Record*
1	upland	good	loose & sandy	good to bad (dis.)
2	hilltop	good	hard & refractory	poor
5	hillside	good	hard & heavy	good for 4 yrs.
9	valley	fair	loose & light	bad (dis.)
12	bottom	poor	very hard & heavy	good to bad (dis.)
14	bottom	fair (87)	hard & heavy	poor until mulch.
15	bottom	good	hard & heavy	good to date
18	hilltop	fair	loose & light	should be good
27	bottom	poor	hard & refractory	poor
29	bottom	poor (87)	hard & heavy	disease spread rap.
30	upland	good	hard & heavy	good
34	hilltop	good	hard & refractory	
37	upland	good	hard & refractory	poor
38	upland	good (82)	hard & heavy	

PANAMA DIVISION

100	bottom	good	hard & refractory	fair
110	valley	–	hard & heavy	good to bad
121	bottom	orig. poor	hard & refractory	bad till drained

201	hillside	good	hard & refractory	poor
203	upland	good	hard	good
204	upland	good	hard	good
205	upland	good	hard	good
206	upland	good	hard	very poor
210	hillside	good	hard	poor
211	upland	good	hard	poor
212	upland	good	hard	very poor
213	hillside	good	hard	very poor
221	bottomland	fair	hard & stiff	poor
222	hilltop	natural	hard & stiff	very poor
226	upland	good nat.	hard & refractory	good
227	upland	good nat.	hard & refractory	good
228	upland	good nat.	hard & refractory	good
229	hillside	good nat.	loose & light	poor
230	bottomland	poor (91)	hard & stiff	poor
231	bottomland	poor nat. (100)	hard & stiff	
235	bottomland	natural (92)	hard & refractory	
236	upland	good	hard & refractory	
237	upland	good	hard & refractory	
238	upland	good	hard & refractory	

HONDURAS DIVISION

No.	*Topography*	*Drainage*	*Physical Condition*	*Record*
302	valley	poor (90)	hard & refractory	poor
304	valley	poor (82)	hard & refractory	poor
305	valley	poor (67)	hard & refractory	poor
306	valley	poor (82)	hard & refractory	poor
310	hillside	good	hard & refractory	good to date
314	hilltop	fair (46)	hard & refractory	poor
321	bottomland	fair (81)	light	good to poor

JAMAICA DIVISION

404	bottomland	fair (52)	hard & heavy	poor, drought
406	bottomland	fair (38)	hard & heavy	fair
407	hillside	poor (90)	hard & refractory	
408	hillside west	good (92)	loose & heavy black	good
410	hilltop	fair (71)	loose & light	good 28 yrs.
412	hillside	fair	loose & light	hurricane
413	hilltop	fair	loose & light	hurricane
415	hilltop	fair (100)	hard & refractory	good (dis.)
416	bottomland	poor	hard & refractory	very poor
417	bottomland	poor	hard & refractory	very poor
419	hillside	fair	hard & refractory yellow	
427	hillside	fair	loose & light	good
428	hillside	fair	hard & refractory	abandoned

COLOMBIA DIVISION

508	hilltop	good natural	light & fine	
514	valley	ditches (57)	hard & stiff	bad
515	valley	ditches	hard & stiff	fair
516	valley	ditches	hard & refractory	bad
519	valley	ditches	very hard & stiff	fair
522	valley	ditches	very hard & stiff	bad
526	upland	ditches (40)	coarse & sandy	bad
527	valley	ditches	hard & refractory	bad

Comparison of Good Farms and Poor Farms

It has been of some interest to compare the mechanical and chemical analyses of selected farms which have been graded according to their histories into "good" and "poor." In those divisions where the Panama Disease has gained a foothold, the classification of the farm as "poor" may be due to the fact that it has had a bad history only since infection took place and not because of any serious deficiency in plant nutrients or objectionable physical character. It is extremely difficult to separate these factors in all instances, and our opinion of the quality of a farm is likely to be somewhat distorted. It is undoubtedly true that in many instances a farm which is otherwise rich and of excellent character is receiving by flooding or by planting with infected bits or by the use of infected utensils a wholesale infection, whereas if such infection had not taken place its productivity would have been greatly prolonged, and if the infection could be wiped out this productivity might be readily restored.

I have selected six farms from each division characterized as "poor" and six others from each division characterized as "good." The average by divisions and the average for all are presented in the two brief tables following. It will be noted in general that the poor farms differ from the good farms very slightly in their chemical character. They do, however, generally show a somewhat lower percentage of lime, a somewhat higher percentage of magnesia and a somewhat lower percentage of organic matter and total nitrogen. The potash figures are in general very similar. In the physical examination it will probably be found that more farms with hard, refractory soil are in the "poor"

group than in the "good" group. While these conditions are slight when expressed as percentages, they amount to a good deal when translated into terms of pounds per acre and indicate the desirability of lime, organic matter and nitrogen in generous amounts for successful banana cultivation. The difference in potash, although slight, points also to the desirability of this element in abundance.

Averages of Good Farms

(Six good farms from each division, according to their histories)

Division	*Fine Gravel*	*Coarse Sand*	*Fine Sand*	*Silt*	*Clay*	K_2O	*CaO*	*MgO*	Fe_2O_3	P_2O_5	*Vol. Mat.*	*Tot. N*	*RP*
Costa Rica—3, 6, 13, 16, 20, 25 .	11.6	17.1	22.8	41.9	6.6	.40	1.70	0.94	8.33	.32	11.21	.19	69
Panama—103, 105, 112, 114, 116, 140	0	9.2	17.2	69.0	4.6	.42	2.14	1.32	8.21	.23	7.21	.12	56
Guatemala—202, 207, 208, 214, 218, 223	0	0	0	96.0	4.0	.37	.97	.82	6.37	.18	5.83	.18	77
Honduras—303, 307, 309, 322, 323, 327	0	0.2	5.3	91.0	3.5	.46	1.02	.87	6.66	.14	6.69	.09	64
Jamaica—408, 411, 418, 424, 426, 430	0	0	0	95.1	4.9	.32	2.73	1.07	7.71	.15	7.84	.16	69
Colombia—501, 507, 512, 513, 523, 524	0.6	2.0	8.0	86.6	2.8	.45	1.92	1.31	6.74	.18	4.57	.11	49
Average Good Farms	2.0	4.8	8.9	79.9	4.4	.40	1.75	1.06	7.34	.20	7.23	.14	64

Averages of Poor Farms

(Six poor farms from each division, according to their histories)

Division	*Fine Gravel*	*Coarse Sand*	*Fine Sand*	*Silt*	*Clay*	K_2O	*CaO*	*MgO*	Fe_2O_3	P_2O_5	*Vol. Mat.*	*Tot. N*	*RP*
Costa Rica—2, 8, 12, 24, 27, 35 .	1.1	16.9	28.3	40.0	4.7	.27	1.48	1.09	9.50	.21	9.81	.14	63
Panama—100, 107, 113, 121, 136, 139	0	11.8	19.8	63.4	5.0	.42	1.77	1.16	8.93	.28	8.18	.15	62
Guatemala—201, 212, 213, 221, 222, 229	0	0	6.5	90.1	3.4	.29	.37	.36	3.49	.14	5.58	.11	60
Honduras—302, 304, 306, 314, 321, 324	0.3	1.2	12.6	82.8	3.1	.34	.58	.69	5.57	.11	7.03	.13	62
Jamaica—402, 404, 407, 410, 416, 425	0	0	0	95.4	4.6	.33	4.22	.93	9.08	.32	9.39	.20	68
Colombia—514, 515, 519, 522, 526, 527	0.4	0.3	5.8	91.0	2.5	.54	1.94	1.16	6.98	.16	5.43	.06	51
Average Poor Farms	0.3	5.0	12.2	78.6	3.9	.37	1.73	.90	7.26	.20	7.57	.13	61

Divisional Averages

The following table gives the divisional averages for all the divisions in a form which can be easily compared. These will show at once the particular qualification in which any division falls markedly below the average. Thus it will be seen that the Panama and Costa Rica Divisions, and to a lesser degree the Jamaica Division, are somewhat higher in iron than is generally regarded as desirable. It will be noted that the Guatemala Division is low in potash and extremely low in lime. In this Division the ratio of lime to magnesia is less than one, although the difference is very slight. In a number of farms, however, this preponderance of magnesia is very marked. It will be noted that the Honduras Division and the Colombia Division fall much below the average in total nitrogen, and also that the Colombia Division is considerably below the others in the amount of organic matter. The average for all samples shows approximately the type of analysis which may be regarded as satisfactory, although I believe that the figures for organic matter and nitrogen are below what would be most advantageous. Classifying the divisions as to their relative composition we have the result shown on page 589.

Divisional Averages

Division	Fine Gravel	Coarse Sand	Fine Sand	Silt	Clay	K_2O	CaO	MgO	Fe_2O_3	P_2O_5	Vol. Mat.	Tot. N	RP
Costa Rica	.5	13.9	24.9	55.9	4.8	.37	1.73	1.08	8.93	.31	7.85	.14	58
Panama	8.6	15.9	26.8	43.2	5.5	.34	1.54	1.07	9.08	.24	10.90	.20	63
Guatemala	0.3	0.2	3.4	93.1	3.0	.31	.61	.63	4.66	.15	5.67	.14	64
Honduras	1.8	2.3	10.4	82.5	3.0	.51	1.57	.92	5.06	.15	6.56	.09	64
Jamaica	0	0.6	0.8	93.8	4.8	.33	2.88	.87	7.35	.18	7.40	.14	66
Colombia	1.0	2.5	10.3	83.7	2.5	.47	2.19	1.28	6.85	.22	4.76	.08	48
All samples	2.1	5.9	12.7	75.4	3.9	.39	1.75	.97	6.99	.21	7.19	.13	61
Rank 1	C.R.	C.R.	C.R.	C.R.	J.	H.	J.	C.	C.R.	P.	C.R.	C.R.	J.
2	H.	P.	P.	P.	G.	C.	C.	P.	P.	C.R.	P.	P.	H.
3	C.	C.	C.	H.	C.	P.	P.	C.R.	J.	C.	J.	G.	G.
4	P.	H.	H.	C.	H.	C.R.	H.	H.	C.	J.	H.	J.	C.R.
5	G.	J.	G.	G.	G.	J.	C.R.	J.	H.	H.	G.	H.	P.
6	J.	G.	J.	J.	C.R.	G.	G.	G.	G.	G.	C.	C.	C.

The following facts should be recorded with reference to the different divisions as possibly bearing upon the above data:

Costa Rica. Santa Clara samples represent upland conditions, remainder of samples are nearly all alluvial. No virgin woodland samples. Disease has been big factor in loss of farms. Hurricanes have very little influence. No distinct dry season.

Panama. Samples include very few poor banana soils. A large proportion of the samples are subject to flood conditions. Talamanca samples represent virgin woodland. Disease has influenced production in Changuinola and Sixaola, but not in Talamanca. Production very little influenced by hurricanes, except in 1908 and especially in San San District. No distinct dry season.

Guatemala. Both hill samples and alluvial samples. Virgin woodland in central lands. Production influenced somewhat by disease, but more by abnormal floods. Most of the hill samples are "talpetate." No distinct dry season.

Jamaica. Locality of sample on south end of island (St. Catherine) has distinct dry season, and irrigation is necessary. Localities of other samples on north and east end of island have very heavy rainfalls. No virgin woodlands. Most of the samples are from very old cultivations, some over one hundred years. Extensive cultivation with plows and harrows has made samples from three depths quite uniform. Production much influenced by hurricanes, but very few floods. Most of the soils have grown other crops besides bananas. Animal and green manure have been added in many cases. Soils show high lime content. Many hill samples. Disease has had relatively little influence on production.

Honduras. All alluvial samples. Virgin woodland in Bogran Estate, San Alejos. The Ulua River samples are considered ideal banana soils, and are mostly from farms over ten years old. Most of other samples are from young farms. Disease has had practically no influence on production, with the exception of some Colorado Disease. Very few hurricanes and no distinct dry season.

Colombia. A distinct wet and dry season. Irrigation about ten months in year. Salitrous sample in Rio Frio (Olivo). Action of earthworms in the soil is marked in this Division—not noted in any of the others. Banana soil is dependent upon location in this Division, whether it can be irrigated or not. Disease has had no influence on production. No hurricanes, but severe local mudstorms.

XII. General Conclusions

The general conclusions from the whole study may be summed up in the following statements:

1. The soils of these divisions as a whole show a mechanical analysis and a chemical analysis which may be regarded as satisfactory except for the deficiencies noted above in organic matter and nitrogen.

2. Potash, which is regarded as an essential mineral element for the particular development of the banana, is found in all divisions in fairly liberal amounts and if available should in general be sufficient to maintain the cultivations for long-continued periods.

3. Lime is found in moderate amounts in all divisions except Guatemala, but numerous instances appear in the tabulated statements where a local deficiency occurs. Since lime is of immense value in liberating potash from the soil and in neutralizing soil acidity, it is probable that even higher percentages than are here shown would be desirable.

4. Iron occurs in somewhat more than the normal amount for agricultural soils in general in four of the six divisions, although it is probable that this is characteristic of tropical soils. Since iron tends to bind phosphoric acid and render it inert and unavailable for plant food it seems probable that the figures obtained in the analyses for phosphoric acid give rather undue assurance of its liberal occurrence and that further introduction of phosphates might be followed by excellent results.

5. Organic matter and nitrogen, as have been already suggested, appear somewhat lower than is desirable. This again is apparently a characteristic of tropical soils, although the Costa Rica Division with

a percentage of organic matter of nearly 11 indicates that these low figures are not universal.

6. Retentive power of the soil for water appears to bear no relation to the agricultural history except in those instances where it is very high or very low, and then only when the soil is practically impervious or very porous respectively.

The chemical examination and the mechanical analyses are disappointing in that they show no relation to the occurrence of disease, especially Panama Disease, aside from the fact that a few farms with low nutritive value have the disease in intensive form. This would seem to be because of low vitality through deficient nutrition, although it is not entirely safe to draw this conclusion in view of the fact that we do not know the manner in many instances in which the infection was introduced or how extensive it was at the time of introduction. A continued study of the figures of disease in selected areas, such as the Estrella Valley, the newer districts in Guatemala, Talamanca District in Panama and in Honduras where every precaution is taken to prevent infection through the ordinary controllable agencies such as utensils, men and animals, should give us some information on this important matter, and in these regions occasional duplicate soil analysis might be of interest and value.

XIII. Recommendations

1. The foregoing work has given the most fundamental knowledge regarding the chemical composition of what may be regarded as typical tropical soils. While the plant nutrients seem to be in most instances reasonably abundant, I believe it would be of advantage to study a few selected locations experimentally with reference to the availability of the ingredients for the banana plant. This would particularly apply to phosphoric acid and potash.

2. The general deficiency of nitrogen leads me to believe that bacteriological changes in the soil by which nitrogen is gathered and rendered available for crops are not taking place with the intensity which is possible or which is desirable. I believe, therefore, that the next line of soil investigation which should be conducted is on the occurrence and rate of action of nitrifying bacteria and of nitrogen-fixing bacteria in tropical soils, and especially in the farms devoted to banana cultivation.

3. In view of the rather moderate amount of lime which is shown in a number of divisions I believe that it would be of interest to conduct experiments on the seasonal changes in soil acidity in certain banana farms of the different divisions and to determine if possible whether the lime and other alkalies are ample to take care of the organic acids which are produced by decomposition processes and as a result of root action. I would recommend that experiments on this point be projected and carried out as soon as the general conditions of cultivation, handling and shipment have returned to normal.

4. I would recommend that somewhat more extensive experimentation than has been conducted be undertaken with reference to the introduction of organic matter and nitrogen into the soil through

the agency of cover crops or leguminous types. Certain crops such as soy or velvet beans, cowpeas or peanuts, sown in land which has been abandoned due to poor production, but which is not intensively diseased, might conceivably restore these lands to a condition when they could again be profitably cultivated for bananas. Such experimentation would be particularly valuable in those areas which have shown very low results in both organic matter and nitrogen.

5. I would again express my belief that a thorough study of the bacteriology of tropical soils would now be of the greatest value.

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